TAXONOMIC AND ECOLOGICAL STUDY OF THE ORCHID FLORA OF NGONG HILLS

BY

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D E C L A R A T I O N

This thesis is my original work and has not been presented for a degree in any other University.

Bkhayota

BEATRICE NANGAMI KHAYOTA

This thesis has been submitted for examination with my approval as University Supervisor.

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A B S T R A C T

The *Orchidaceae* is one of the largest and most diverse families of the flowering plants, including 20,000 to 25,000 species distributed all over the world.

The work presented here is the study of the taxonomy and ecology of the orchid Flora of the Ngong Hills. The hills lie on the edge of the Rift Valley, about 20 kilometers South West of Nairobi and they have been identified as an endangered ecosystem.

The present study reveals that of the expected 21 species in 13 genera, only 17 species in 11 genera were recorded including 4 new records for the area. Keys for the determination of these species and a detailed morphological account of each genus and species is prepared. The ecological association of the orchid flora of the area is also discussed.

Results also indicate that there has been extensive deforestation in the area. Possible solutions and recommendations regarding its rehabilitation are suggested.

The accumulated results have illustrated that orchids are extremely specialized environmentally and sensitive to slight variation, making them potential 'markers' for vegetation analysis.

A C K N O W L E D G E M E N T S

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CHAPTER ONE

1. INTRODUCTION

The *Orchidaceae* is one of the largest and most diverse families, including somewhere between one tenth and one fourteenth of all flowering plants (Dressler 1981). An accurate estimate of the number of valid species that exist is difficult to make because few orchid groups have been well studied and a great deal of botanical description and revison is still going on. Considering the many uncertainities a figure between 20,000 and 25,000 orchid species seems reasonable (Dressler 1981).

Knowledge of tropical orchids is still fragmentary and it is not yet known as to how many orchid species occur in the tropics and of these how many are rare and endangered in the wild and consequently in need of protection. Orchids in Africa are conspicously different from those found in other parts of the world Stewart & Hennessy (1981). Owing to their apparent diminitive magnificence unlike orchids of tropical Asia and Americas, African orchids have not received the attention they deserve.

Stewart et al. (1970, 1981), Williamson (1977) and Pottinger (1983), have presented a generalized account of orchids in South Africa, South Central Africa and Africa respectively.

Moreau & Moreau (1943) wrote a key and a checklist of epiphytic orchids, whereas Piers (1951, 1959, 1968) dwelt on the orchids in East Africa. Leedal and Cribb (1977), studied orchids in what they considered unusual habitats for the group in East Africa.

Recent publications on East African orchids include the *Orchidaceae* in Flora of Tropical East Africa, Part 1 by Summerhayes (1968), Cribb (1984) Part II and Cribb and Stewart (in prep.) Part III.

In Kenya the first description of the family *Orchidaceae* was included in Flora of Tropical Africa by Rolfe (1897) and Piers (1951) gave a more pertinent account of orchids in Kenya. Copley (1964) compiled the first checklist of Kenya orchids which include 212 species in 38 genera. Later Stewart (1971) compiled a second checklist which included 247 species in 45 genera. Little work had previously been done on the orchid flora of Ngong Hills.

Van Someren (Personal communication), observed 20 species of orchids, whereas Meyer (Personal communication) recorded 11 species. Records from E.A. Herbarium indicate that 21 species of orchids have been collected from Ngong Hills. An indepth reserch into the taxonomy and ecology of the orchids of Ngong Hills was deemed necessary in order to give an updated account of the flora of the area.

1.1 Characteristics of the Orchid family

Orchids comprise what has sometimes been described as the 'royal family of plants',(Stewart *et al.* 1982). Orchids are individualists and their flowers display an amazing variety of shape, colour and pattern giving rise to the most bizarre of forms, a characteristic which makes the orchids elicit outstanding interest. There is probably no family that exhibits such a range of floral variability as the *Orchidaceae* (Schultes 1960). Special technical terms with precise meanings are used to describe them.

According to Dressler (1981), there are several features which serve to separate the *Orchidaceae* from all other families.

The stamens are all on one side of the flower rather than being symmetrically arranged, and most orchids have only one fertile stamen.

The stamen and the pistil are at least partly united and in most orchids, these parts are completely united to form a single structure, the column.

The seeds are tiny and numerous. They are devoid of endosperm and in germinating, they are dependent on food from their environment. A symbiotic relationship exists between the orchids and certain mycorrhizal fungi which provide the sprouting orchid seed with its early supply of food. The orchid seed is incapable of passing beyond the embryonic stage under natural conditions, unless it is invaded by the hyphae of a mycorrhizal fungus(Schultes 1960).

The flower usually has a lip or labellum, which is so unlike the other two petals.

The flowers usually twist around in their course of development in the process known as resupination, so that the lip is on the lower side of the flower when it opens.

Part of the stigma (the rostellum) is usually involved in transferring the pollen from one flower to another.

The pollen is usually bound together in a few large masses known as pollinia.

The structure of the orchid flower is enormously varied and often specially adapted to fit the shape of the head, body or feet of the insect visitor that will pollinate it.

1.2 History of the family Orchidaceae

The first appearance of the Greek word ὄρχις "Orchis" was in the Greek manuscript, "Enquiry into plants", written by Theophrastus, (370 - 285 BC.),and who can be called the father of orchidology.

In the first century of the Christian era, the Greek botanist of Asia Minor, Dioscorides recognised 500 plant species, 2 of which were designated as "Orchis". Orchis which gives the name to the orchid family is the Greek word for testicle, in allusion to the fancied similarity of the enlarged roots or bulbs of many of these plants to the testicles of animals or humans.

The exact system of terminology developed during the middle ages and it formed the basis of later detailed descriptions. The first outstanding figure in systematic botany was the Swede Carl von Linné , commonly known as Linnaeus. In his "Species Plantarum" (Ed. 1753) he placed all the orchids in his class XX - Gynandria and class II - Diandra. In the first edition he listed 8 genera of orchids. In his second edition (1763) he lists 102 species in 8 genera. His collection by then contained 31 species of orchids.

The Frenchman Antoine Laurent de Jussieu (1748 - 1836) placed orchids in his class IV, with the stamens epigynous.

In 1824,Augustin Pyrame de Candolle in his "Prodromus Systematis Naturalis Regni Vegetabilis", included orchids in monocotyledons.

In 1788, Olof Swartz, the first orchid specialist, published the"Prodromus Descriptionum vegetabilium" in Indiam Occidentalem, where he followed the Linnaean system and briefly described the species belonging to eight orchid genera.
In the "Flora Indiae Occidentalis" (1797 - 1806) 13 genera and 77 species of orchids were recognized.

In 1800 Swartz published what is probably the earliest article devoted exclusively to Orchids, "Orchidernes Slagter Orch Arter. Upstallde". He was the first to recognize formally the divisions of the Orchid family into Monandrae and Diandrae.

Robert Brown (1773 - 1858) in his "Prodromus Florae Novae Hollandiae et Insulae Van-Diemen", gave an elaborate description of the family *Orchideae*

In 1818 in an article, "De Orchideis Europaeis Annotationes", L.C. Richard gave a detailed explanation of all parts of the Orchid plant, using definite and often new terminology that persists today.

John Lindley (1799 - 1865) published, "The Genera and Species of Orchidaceous Plants;" (as seen in Withner, 1959), marking the beginning of modern orchidology and was the first to use the family name ***Orchidaceae***. In 1862 Charles Darwin in "The Various Contrivances by which Orchids are Fertilised by Insects", discussed in detail the role played by insects in cross-pollination and adaptations produced by the Orchids in response to this problem.

Other important contributions to systems of classication of the Orchid family were by George Bentham (1881), Sir Joseph Dalton Hooker (1883), and Ernst Hugo Pfitzer (1846 - 1906).

Alfred Cogniaux (1841 - 1916), Fritz Kraenzlin (1867 - 1947), M.J. Godfery (1857 - 1845) and J.J. Smith (1867 - 1947) are some of the recognized authorities on the Orchid family.

One of the recent Orchidologists is Friedrich Richard Rudolf Schlechter (1872 - 1925), who published the first edition of "Die Orchideen", (as seen in Withner, 1959).

In America the leading figure in the ***Orchidaceae*** was Oakes Ames, and at Kew, England, Victor S. Summerhayes, Phillip Cribb and Joyce Stewart, have carried out much work on Orchids especially the African Orchids.

1.3 Morphological description of the family Orchidaceae

Perennial herbs, terrestrial, epiphytic, saprophytic or very rarely subterranean or aquatic, with soft tubers, pseudobulbs, rhizomes or rootstocks with mycorrhizal fungi in the roots and usually elsewhere. Growth usually sympodial, occasionally monopodial. Stems leafy or scapose, frequently swollen at the base into a "pseudobulb", those of epiphytic species often bearing aerial assimilating roots protected from excessive water-loss by layers of dead cells called the velamen.

Leaves rarely hairy, undivided except in some cases at the apex, alternate or very occasionally opposite, often distichous, frequently fleshy and often terete or canaliculate,sometimes reduced to scales, almost always with a basal sheath which frequently surrounds the base of the peduncle, sometimes articulated at the base of lamina, and sometimes with a false petiole.

Inflorescence spicate, racemose or paniculate, terminal and/or axillary, the flowers rarely secundly or distichously arranged, or flowers solitary. Flowers bracteate, hermaphrodite or very rarely polygamous or monoecious, zygomorphic, sessile or variously pedicellate, most often twisted through one hundred and eighty degrees(resupinate), occasionally not twisted or twisted through three hundred and sixty degrees.

Perianth epigynous, composed of six segments, usually free but less frequently variously adnate, connate or adherent to one another or to the column, arranged in two whorls; both whorls similar or outer whorls (sepals) calyx-like and inner (petals) corolla-like or outer whorl corolla-like and inner very reduced.

Median segment of outer whorl ("dorsal sepal") often different in size and shape from the two laterals, sometimes saccate or with one or two spurs. Median segment of inner whorl (lip or labellum) entire or variously lobed, frequently laciniate or fimbriate, often brightly coloured and frequently spotted or otherwise ornamented, often bearing crests (keels or carinae) along its length or with central portion (disk) or throat bearing a callus or cushions of hairs, often produced backwards into a sac or spur up to thirty centimeters long and sometimes with nector at the apex, often differentiated into two or three parts, basal part termed hypochile, often hinged to the base of column or narrowed into a claw; middle part termed mesochile; apical part termed epichile.

Stamens one, two or three, more or less united with the style to form a special organ termed the column (gynostegium), apical part of which may be produced laterally into wings or vertically into steldia, basal part often produced downwards, to form a column-foot. Mentum or chin frequently formed from lateral sepals where tepals join column foot. Anthers attached by their bases or apices, opening by a slit lengthwise or often operculate; pollen in distinct tetrads, sticky or agglutinated into two, four, or eight pollinia; pollinia mealy , waxy or horny masses, often divided into a number of small portions (sectile); at one end each pollinia occasionally drawn out into a sterile caudicle. Ovary inferior, one-locular with three parietal placentas or rarely three-locular with axile placentation, produced at the apex to form the column, ovules very small and numerous, stigmas three, fertile or more usually the two lateral ones fertile and the other transformed into an outgrowth (rostellum) lying between the anther and the lateral stigmas; part of the rostellum often modified into a sticky disk or disks called viscidia to which the pollinia are attached by one or one stalks (stipes) also derived from rostellum or by the sterile caudicle.

The whole structure of pollinia, stipes or caudicle and viscidium form the pollinarium. Fruit a capsule opening laterally by three or six longitudinal slits. Seeds very numerous and small, without endosperm and with undifferentiated embryo, often markedly winged.

1.4 Geographical distribution

Orchidaceae is a cosmopolitan family with representatives in every country ranging from northern Sweden and Alaska to Tierra del Fuego and Macquarie Island. Their ecological range is equally wide with plants occuring in all but the most extreme environments such as the sea, the driest deserts and tops of the coldest mountains, though they may be found in oases, in sheltered desert canyons and in cactus thorn scrub or thorn bushland

Orchids are much more diverse in the tropics and subtropics primarily between the latitudes of Cancer and Capricorn and becoming increasingly less diverse in cool temperate and subartic regions.

According to Dressler (1981), there are 153 species in 26 genera in North America, 8,266 species in 306 genera in Tropical America and 3,131 species in 134 genera in Tropical Africa. In Eurasia there are 664 species in 49 genera, while in Tropical Asia, there are 6,800 species in 250 genera and in Australia 602 species in 68 genera.

The most striking features about the distribution of orchids, is that different continents have distinctive orchid floras (table 1).

Table 1

Distribution of prominent Orchid genera

(After Floyd S: Sattleworth, Herbets, Zim and Gordon W. Dilton in Priti Shukla and Shilal P. Misra 1979)

GENERA	N. America	C. America	S. America	Europe	Africa	India	Malaysia	Burma	Philippines	Australia	N. Zealand
Bulbophyllum	x	x	x		x	x	x	x		x	x
Cattleya	x	x	x								
Coelogyne						x	x	x			
Cymbidium					x	x	x	x		x	
Cypripedium	x			x		x					
Dendrobium						x	x	x	x	x	
Epidendrum	x	x	x								
Habenaria	x	x	x	x	x	x	x	x	x		
Laelia	x	x	x								
Masdevallia	x	x	x								
Maxillaria	x	x	x								
Odontoglossum	x	x	x								
Oncidium	x	x	x								
Paphiopedilum						x	x	x	x	x	
Phalaenopsis							x	x	x	x	
Pleurothallis	x	x	x								
Spathoglottis						x	x	x	x		
Spiranthes	x	x	x	x			x	x	x	x	
Vanda						x	x	x	x	x	
Vanilla	x	x	x		x						

1.5 Economic Importance

With the exception of the flavouring essence vanilla obtained from *Vanilla planifolia* G. Jackson in Andr. and the questionable nutritive "Salep", from the tubers of certain species, orchids have little current economic use, other than as the basis for a vast floricultural industry.

While orchids make but a minor contribution to the world's economy today, this was not always so.

It will never be known when man first used an orchid. The first definite information is from folk medicine with the earliest records from China, Japan, India and the Eastern Mediterranean region dating from the sixth and fifth centuries B.C. (Arditti 1984).

The uses of orchids are as varied as their sizes, shapes, fragrances and distribution. Some of the uses are astounding, others prosaic. Orchids have figured in legends, magic, religions and have been used in many societies for food flavouring and medicine, as aphrodisiacs, decoration, arts and crafts (Arditti 1984).

Orchid flowers are cultivated for trade in Kenya.

(a) Religion, Superstition and Magic

Orchids have long been associated with magic and superstition, usually in connection with their supposed aphrodisiac effects on humans and animals. During the middle ages, the predestined use of a plant was indicated by its form, therefore *orchis* roots were considered as influencing sexual phenomena.

Orchids were used as love charms, in religion during baptism, marriage, burial and to express devotion to God and Saints.

(b) Floral Emblems

Orchids have been adopted as state or national flowers, for example *Cattleya skinneria* Batem is the national flower of Costa Rica, *Dendrobium bigibbum* Lindl. is the state flower of Queensland and *Peristeria elata* Hook. is the national flower of Panama, among others.

(c) Food

The roots, tubers, bulbs, flowers, stems and leaves of various orchid genera were used as food.
The tuberous roots of some orchidaceous plants yield salep, a nutritive meal starch or jelly.
Vanilla is the sole product from orchids which is of significant economic importance in the world today.
It is a product of several species of the genus *Vanilla* Sw. and is extracted from fermented, partially ripe capsules and is used in food flavouring. There are also reports of the use of orchids in decoctions, infusions, tisanes and similar preparations.

(d) Medicines

Medicinal uses of orchids have been widespread and many have the reputation of being aphrodisiacs, but these have been without basis and most of the orchid products formerly mentioned in herbals and pharmacopoeias, have been dropped from modern lists as they have been shown to be ineffective.

There are many other uses of orchids in arts and crafts. The fibres and stems have been used in basketry, and pigment and adhesives can be obtained from some orchids. Roots have been used as cordages and binding strings.

Various nonindustrialised peoples have used orchids for clothing, cosmetics, decoration and ornaments. Narcotics, fish poisons and insecticides have been prepared from orchids(Arditti 1984).

Orchids are the basis of a flourishing horticultural industry involving millions of dollars annually. A large number of species are valued for their unexcelled beauty and are cultivated with sometimes fanatical devotion and enormous numbers of new hybrids are produced, often commanding high prices (Heywood 1978).

1.6 Phylogeny

The orchids from the standpoint of orchidology seem not to have positive or useful fossil records (Arditti 1984). Orchids are not favourable candidates for fossilization because they do not occur and probably never did grow in habitats favourable to the usual modes of fossilization. The earlier history of the family is therefore little known.

There is some dispute as to the exact time of origin of the family but most workers agree that currently and in the immediate geologic past, the *Orchidaceae* as a vast and highly specialized family may be a comparatively young group in an extremely active period of evolution.

In the absence of a fossil record, we can only guess on the basis of what we know of the family about the major trends of evolution (Arditti 1984). Agreement seems to be rather general that *Orchidaceae* represents the most advanced group of Monocotyledoneae and that they have arisen through the *Liliaceae* or from a common prototype (Schultz 1960).

Bentham and Hooker placed the family under *Microspermae* as the first order in monocotyledons, whereas Engler placed the family *Orchidaceae* in the sub- order *Cynandrae* of the order *Microspermae* at the end of monocotyledons.

The family is related to the epigynous components of the *Liliflorae (Liliales)*, it shows affinities with *Burmanniaceae*, *Apostasiaceae* and forms a connecting link with the families of epigynous *Liliales*, which according to Hutchinson formed a rootstock for the origin of the family *Orchidaceae* as a result of development of floral parts, and reduction in the number of stamens during the course of evolution.

According to another view, the family originated from *Musaceae* or its ancestor on the basis of similarity in structure and construction of the flower of *Orchidantha (Musaceae)*.

It cannot be said as to where orchids first evolved, though a tropical area seems indicated.

1.7 Objectives

The Ngong Hills is an area where extensive deforestation has taken place in quest for agricultural land for the ever increasing population in the surrounding area. As a result, the indigenous forests are dwindling rapidly and many epiphytic orchid species are in danger of losing their natural habitat. Ground orchids face extinction too due to heavy close grazing and trampling.

The orchids of East Africa are valued and cultivated by a growing circle of euthusiasts, resulting in excessive collection and stripping forests of orchids; yet orchids grow slowly and do not multiply profusely, so that regrowth is very slow.

Unfortunately re-afforestation may not compensate for the loss of indigenous trees because the process usually involves planting of exotic softwoods which might never offer congenial homes to orchids.

The object of the study is therefore:

(a) To delineate the natural vegetation into habitat types according to specific plant associations and distribution.

(b) To study the ecological associations of the orchid flora. The major factors considered include the habitat, the orchid/host species relationship, type of substrate, altitude, frequency and associated species.

(c) To build up a herbarium collection of the orchid flora of Ngong Hills for future reference and distribution of voucher specimens to other herbaria.

(d) To compile a checklist of the orchids of Ngong Hills, which may be of use to future workers in the area.

(e) To carry out a survey on the impact of man on the flora of Ngong Hills in relation to tree-cutting, overgrazing and removal of moss from trees, and measures that are being taken to rectify the situation, and to draw out recommendations regarding the rehabilitation of the denuded hillslopes.

CHAPTER TWO

2 STUDY AREA

2.1 Location

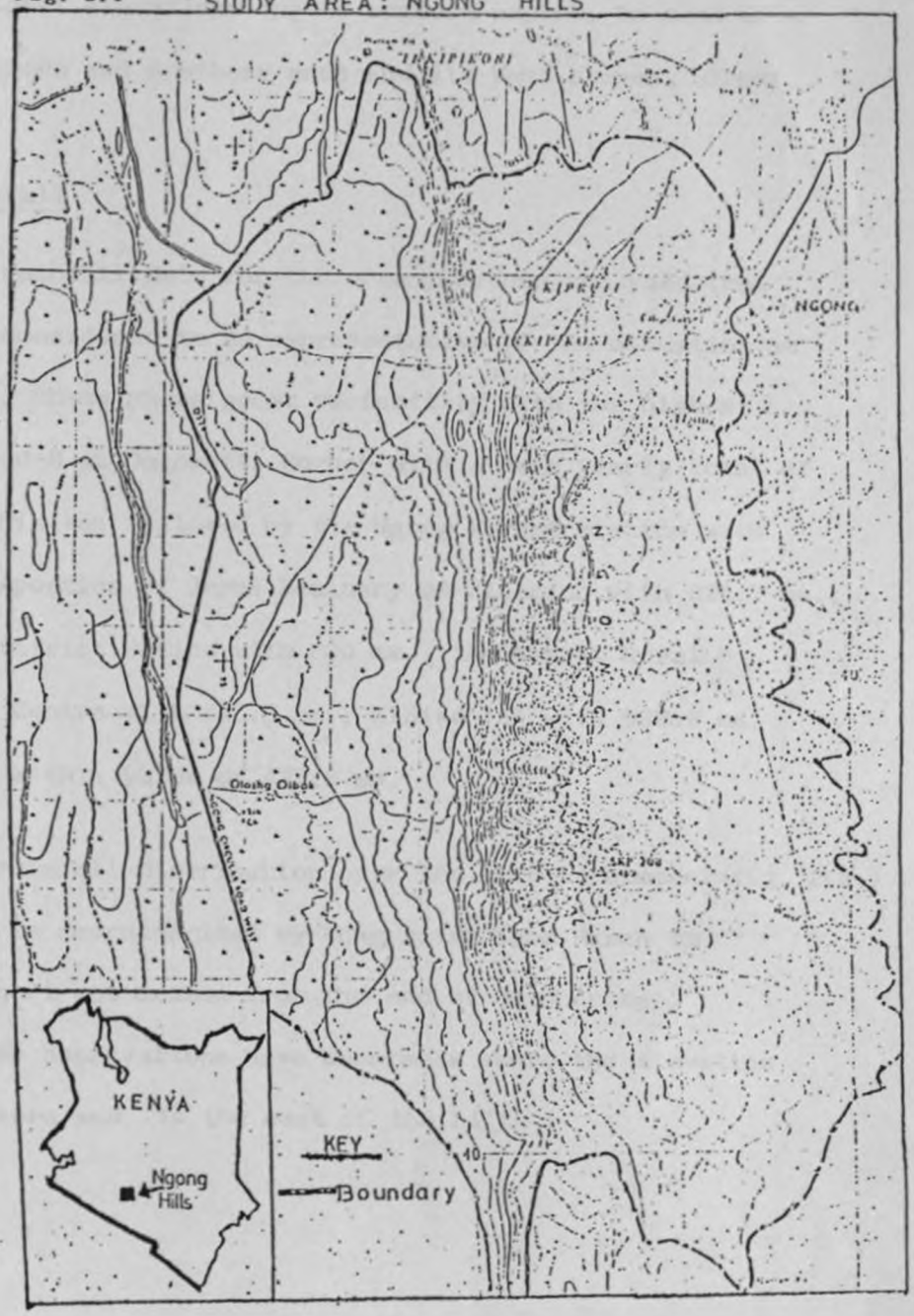
This study was carried out at the Ngong Hills also known to the Masai as the Oloolaiserr hills. The hills lie prominently on the edge of the Rift valley, about 20 kilometers South West of Nairobi, in Kajiado district.

The area falls on latitude 1° 25' S, longitude 36° 38' E and at a range of elevation from 1,800 meters to 2,461 meters above sea level. The hills form a ridge approximately 13 kilometers long and five kilometers wide.

The area is bounded to the East by the Ngong circular road East, which joins the Ngong circular road West to the West and Magadi road which forms the Southern boundary, enclosing an area of 75 Km.sq.

A map of the study area prepared by the Survey of Kenya in 1975, sheet 148/3 and scale 1: 50,000, shows the main geographical features and the study site. Fig.2.1

Fig. 2.1 STUDY AREA: NGONG HILLS



2.2 CLIMATE

The climate of the Ngong hills exhibits extreme variability, mainly as a result of topographic influence. The hills are fairly cool with the climate varying from semi-humid at higher elevations on the eastern aspect, to semi-arid at the northern and southern ends and its West slopes, (Olson in prep.)

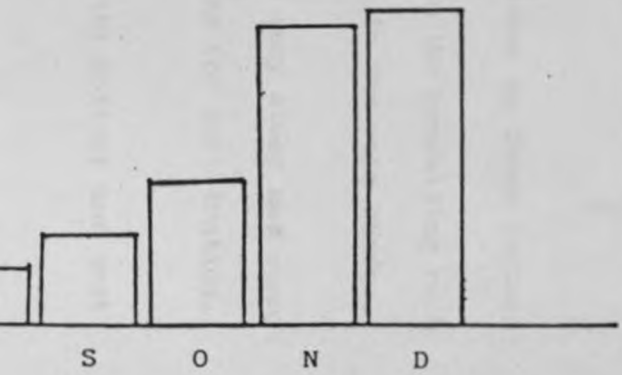
2.2.1 Rainfall

The rainfall data for the area have been analysed from 7 stations considered to be representative of the situation at Ngong Hills. These shows great variability with the highest values recorded at Dagoretti Corner with a mean yearly total of 1049 mm. This was followed by the Ngong Forest station with 938.2 mm. Apostles of Jesus Seminary at Kiserian with 825.7 mm., the Ngong District Office with 820 mm., the Maasai Rural Development Centre with 648.5 mm., Kibiko 'A' with 599.3 mm. and Kisamis with a value of 477.8 mm.

The rainfall distribution over the year is bimodal (fig. 2.2.) The climate is characterized by long rains from March to May and a short wet season from the end of October to November. No observations have been made above the elevation of 2,042 meters and to the west of the hills.

Fig. 2.2 Monthly rainfall for the period beginnin
January 1976 to December at Ngong
District Office Station.

Source: Kenya Meteorological Department



It is therefore, not possible to quantitatively assign rainfall values to these higher elevations (Olson in prep.)

The Western side of the hills is drier than the Eastern counterpart.

According to Olson (in prep.), this is due to three factors:

(a) The Western side faces away from the prevailing rain bearing winds and is therefore, in the rain shadow.

(b) The slopes on the West side are very steep and runoff is accelerated giving little time for infiltration.

(c) The West facing slopes receive the hottest and most drying rays of the sun.

2.2.2 Temperature

Temperatures are fairly constant throughout the year. The average temperatures decrease with elevation with the mean annual temperature at the summit being 14°C whereas at the base, the mean annual temperature is 19°C.

The highest temperatures occur in March while the lowest are recorded in July. The greatest range of temperature occurs in February (Met. Dept.).

2.3 The soils of the study Area

The topography and geology of the area have had a great effect on the development of the soils.

The soils of this area have had a complex evolution and often the profiles reveal that they are a result of the weathering of volcanic ash that fell on well developed soils (Olson, in prep.)

At the top of the Hills, the soils are well drained, shallow to moderately deep dark reddish brown, friable humid, rocky and stony, clay loam (humic, CAMPISOLS, rocky and partly lithic phase).

To the north around Ngong town, the soils are well drained, extremely deep, dusky red to dark reddish brown, friable clay over rock, pisoferric or petroferric material (entric NITISOLS, with nitro-chronic ACRISOLS, partly pisoferric or petroferric phase).

The region to the northwest is made up of a complex of well drained to moderately well drained, deep reddish brown firm sandy clay loam to clay in many places with a humic top soil and cracking to moderately calcareous (undifferentiated LUVISOLS, luvic, PHAEOZEMS and chromic VERTISOLS).

The southern slope has well drained, shallow, dark brown, firm rocky and stony clay loam, with inclusions of lava vents (chromic CAMPISOLS, lithic and rocky phase.)

On the eastern slope, the soils are a complex of well drained, shallow to moderately reddish brown, friable stony gravely clay loam, with humic soil (chromo-luvic PHAEOZEMES, partly lithic phase). (Sombroek *et al.* (1982)

2.4 Natural Vegetation

The vegetation of the Ngong Hills is reflective of the topographic position, soils,climate and human influence, and thus is highly variable.

The vegetation corresponds to altitudinal zones as well as aspect.

In Ngong hills most of the natural vegetation has been cleared and the vegetation at present consists of regenerating shrubs, young trees and herbs especially grass.

The indigenous vegetation has been heavily impacted by animal and human influence and few if any "untouched" areas remain. (Olson, in prep.)

Selective cutting of fuelwood, grazing and browsing by animals and burning for cultivation are obvious examples of such modification.

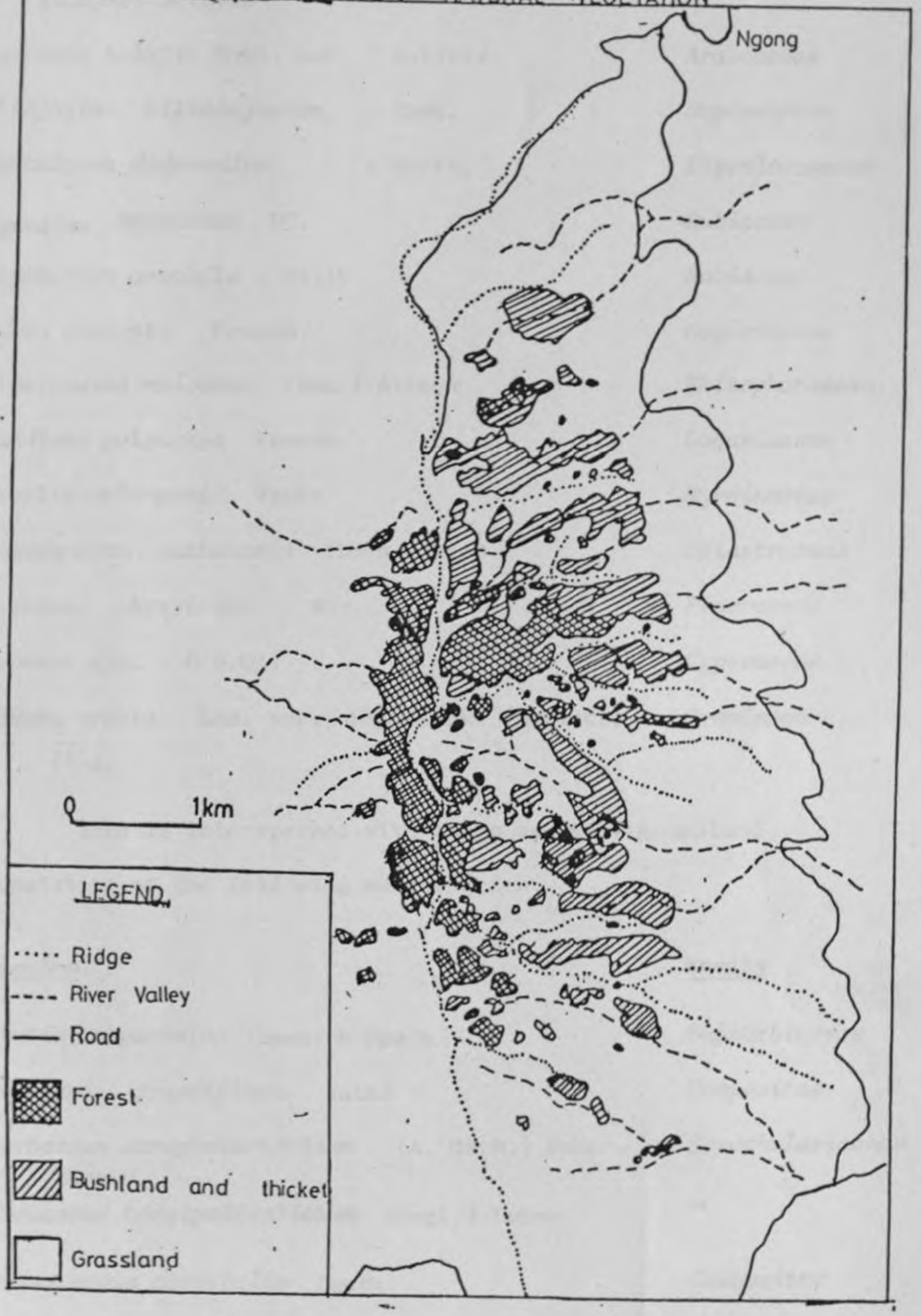
The hill is now covered with patches of natural forest interspersed with grasslands. Most of the forest is on the east side. (Fig. 2.3)

Following is a broad classification based on species composition, height, density and growth form.

Undifferentiated afromontane forest White (1983) exists on the eastern flank from approximately 2,000 m. to the summit at 2,461 m. The dominant species include:

Species		Family
Schefflera volkensii	(Harms) Harms	*Araliaceae*
Ekebergia capensis	Sparrm	*Meliaceae*
Dracaena afromontana	Mildbr.	*Agavaceae*
Maesa lanceolata	Forssk.	*Myrsinaceae*

Fig. 2.3 NGONG HILLS : NATURAL VEGETATION



Canthium oligocarpum (Hiern) ssp *friesiorum* (Robyns) Bridson	*Rubiaceae*
Cussonia holstii Engl. var. *holstii*	*Araliaceae*
Allophylus kilimanjarica Taub.	*Sapindaceae*
Phytolacca dodecandra L'Herit.	*Phytolaccaceae*
Oxyanthus speciosus DC.	*Rubiaceae*
Psychotria orophila Petit	*Rubiaceae*
Nuxia congesta Fresen.	*Loganiaceae*
Cassipourea malosana (Bak.) Altson	*Rhizophoraceae*
Buddleia polyschya Fresen.	*Loganiaceae*
Embelia schimperi Vatke	*Myrsinaceae*
Elaeodendron buchananii (Loes.) Loes.	*Celastraceae*
Peperomia abyssinica Miq.	*Piperaceae*
Cyperus ajax C.B.Cl.	*Cyperaceae*
Ehrharta erecta Lam. var. *abyssinica* (Hochst.) Pilg.	*Gramineae*

This is interspersed with large areas of grassland consisting of the following main species.

Species	Family
Clutia abyssinica Jaub. & Spach	*Euphorbiaceae*
Cineraria grandiflora Vatke	*Compositae*
Verbascum scrophularifolium (A. Rich.) Huber-Morath	*Scrophulariaceae*
Verbascum brevipedicellatum (Engl.) Huber	"
Gutenbergia cordifolia Benth.	*Compositae*
Thunbergia gregorii S. Moore	*Acanthaceae*
T. alata Sims	*Acanthaceae*
Satureia biflora (D. Don) Benth.	*Labiatae*
Cynodon nlemfuensis Vanderyst var. *nlemfuensis*	*Gramineae*

Digitaria abyssinica Jaub. & Spach	*Gramineae*
Pennisetum trachyphyllum Pilger.	*Gramineae*
Themeda triandra Forssk.	*Gramineae*
Cycnium volkensii Engl.	*Sacrophulariaceae*
Carissa edulis (Forssk.) Vahl	*Apocynaceae*
Ajuga remota Benth.	*Labiatae*
Helichrysum odoratissimum (L.) Less.	*Compositae*
Aspilia pluriseta Schweinf. ssp. *pluriseta*	*Compositae*

The forms of these stands are extremely variable. Towards the upper windblown slopes, forest vegetation is more sparse, lower and contorted than on the midslopes. The common species in this zone are *Maytenus heterophylla* (Eckl. & Zeyh.) N. Robson *(Celastraceae)* and lone *Nuxia congesta* Fresen.(*Loganiaceae).*

Towards the northern and southern end of these zones, forest vegetation is now almost completely absent.

There are a few remnant stands of bamboo *Arundinaria alpina* K. Schum.(*Gramineae)* indicating that the area receives over 1,200 mm. rain per year and it has deep soils.

This zone merges with the dry transitional montane forest lower on the slopes, though a precise boundary is difficult to delineate.

Species	*Family*
Dombeya goetzenii K. Schum,	*Sterculiaceae*
Albizia gummifera (J.F. Gmel.) C.A.Sm.	*Mimosoideae* Subf. *Leguminosae*
Dovyalis abyssinica (A. Rich.) Warb.	*Flacourtiaceae*
Hypoestes verticillaris (Linn.f.) Roem & Schult.	*Acanthaceae*
Cyathula polycephala Bak.	*Amaranthaceae*

Bromus unioloides H.B.K.	*Gramineae*

On the lower slopes, thickets of the following species have developed:

Species	*Family*
Maytenus heterophylla(Eckl. & Zeyh.)R.Robson	*Celastraceae*
Abutilon mauritianum (Jacq.) Medic	*Malvaceae*
Lippia ukambensis Vatke	*Verbenaceae*
Rhus vulgaris Meikle	*Anacardiaceae*
Rhus natalensis Bernh.	*Anacardiaceae*
Lantana trifolia L.	*Verbenaceae*
Abutilon longicuspe A. Rich.	*Malvaceae*

This indicates disturbance, overgrazing and poor nutrient status of the soil(Ndiangui, Personal Communication).

The vegetation of the dry Western slope is in marked contrast to that of the Eastern flanks. Montane forest exists only in a few of the highest and most sheltered areas. The common species include:

Species	Family
Olea europeana L. ssp. *africana* (Mill.)P. Green	*Oleaceae*
Euphorbia nyikae Pax	*Euphorbiaceae*
Euphorbia candelabrum Kotschy	*Euphorbiaceae*
Teclea nobilis Del.	*Rutaceae*
Teclea simplicifolia (Engl.) Verdoorn	*Rutaceae*
Euclea divinorum (Hiern)ssp. *keniensis*(R.E.Fries) de Wit	*Ebenaceae*
Heteromorpha trifoliata (Wendl.) Eckl. & Zeyh.	*Umbelliferae*

Vangueria volkensii K. Schum.	*Rubiaceae*
Nuxia congesta Fresen.	*Loganiaceae*
Senecio syringifolius O. Hoffm.	*Compositae*
Senecio petitianus A. Rich.	*Compositae*

The remainder of the west aspect is composed of dry bushland and grassland giving way eventually to the thornscrub of the dry valley floor.

The main species are:

Species	*Family*
Rhus vulgaris Meikle	*Anacardiaceae*
Rhus natalensis Bernh.	*Anacardiaceae*
Cyphostemma nierense (Th.Fr.Jr.) Desc.	*Vitaceae*
Kalanchoe densiflora Rolfe	*Crassulaceae*
Erythrina abyssinica DC.	*Papilionaceae*
Acacia xanthophloea Benth.	*Mimosaceae*
Acacia drepanolobium Sjostedt	*Mimosaceae*
Rumex usambarensis (Dammer) Dammer	*Polygonaceae*
Crassula granvikii Mildbr.	*Crassulaceae*
Cynodon dactylon (L.) Pers.	*Gramineae*
Hyparrhenia cymbaria (L.) Stapf	*Gramineae*
Themeda triandra Forssk.	*Gramineae*
Aloe sp.	*Liliaceae*

CHAPTER THREE

3. TAXONOMIC ACOUNT OF THE ORCHIDS

3.1 Introduction

Little work has been carried out on the orchid flora of Ngong Hills, before. A taxonomic survey therefore, was deemed necessary in order to give an updated account of the orchid flora of the area, in view of the fact that Ngong Hills have been identified as one of the endangered forests in Kenya requiring immediate, if not emergency action to reverse progressive degradation arising from intensive human activity.

3.2 Method of investigation

All the orchid material in the East African Herbarium was checked and a list of orchids from Ngong Hills was prepared. In the field, an intensive ground survey was carried out, making sure that all the possible orchid habitats were explored. Whenever possible, whole plant samples of the orchid, host species and any associated plants were collected in duplicates. Secateurs or long arm pruner were used to detach the epiphytes, whereas a digger or panga were used to dig out terrestrial species. The specimens collected were as complete as possible, by carefully including the vegetative, flowering and fruiting material.

Suitable field notes concerning each specimen were made, using specially printed herbarium collecting books, to ensure that all the relevant information was recorded at the time of collecting. Polythene bags were used to hold the specimens temporarily.

One set of the specimens collected was arranged carefully in drying paper in a plant press and pressed immediately making sure that the specimens appeared as natural as possible. The specimens were then put in a drier to dry at 50°c. Fleshy fruits or flowers that could not make good dried specimens were preserved in spirit. The pressed and dried specimens were taken to the East Afrcian herbarium for accurate identification by the use of various keys and checking against herbarium specimens. The specimens were then mounted on mounting sheets ,preserved and systematically filed in the herbarium cupboards for future reference.

The specimens in the other set were attached to suitable hosts so as to grow, for further observation. Photographs of each species collected were taken.

Regular field observations were made to monitor any changes especially in those species that, owing to their rarity, could not be collected or transferred to the herbarium.

A checklist of the orchid flora of Ngong Hills was prepared, keys to the genera and species were prepared and complete generic and species morphological descriptions were made based on the pattern followed in the Flora of Tropical East Africa.

3.3 Results

Records from the East African Herbarium show that 21 species in 13 genera have been collected from the Ngong Hills. After the field survey, 17 species in 11 genera were recorded. The following is a list of orchids collected from Ngong Hills and arranged in alphabetical order with the collector's (B. Khayota) numbers.

100 *Aerangis thomsonii* (Reichb.f.) Schltr.

120 *Angraecopsis breviloba* Summerh.

125 *Angraecum erectum* Summerh.

185 *Angraecum sacciferum* Lindl.

166 *Bolusiella iridifolia* (Rolfe) Schltr.

65 *Chamaeangis orientalis* Summerh.

69 *Diaphananthe montana* (Piers) Cribb & Stewart

300 *Diaphananthe pulchella* Summerh.

303 *Diaphanthe subsimplex* Summerh.

215 *Disperis kilimanjarica* Rendle.

301 *Eulophia streptopetala* Lindl.

108 *Polystachya campyloglossa* Rolfe

302 *Polystachya cultriformis* (Thou.) Sprengel

98 *Polystachya spatella* Kraenzl.

186 *Polystachya transvaalensis* Schltr.

304 *Rangaeris amaniensis* (Kraenzl.) Summerh.

123 *Stolzia repens* (Rolfe) Summerh.

The following 4 of the above species are new records for the Ngong Hills:

100 *Aerangis thomsonii* Summerh.

125 *Angraecum erectum* Summerh.

65 *Chamaeangis orientalis* Summerh.

98 *Polystachya spatella* Kraenzl.

The following 8 species in 7 genera known from herbarium records to have been collected from the Ngong Hills, were not recorded in the field during the study:

Chamaeangis vesicata (Lindl.) Schltr.

Cyrtorchis arcuata (Lindl.) Schltr.

Habenaria petitiana (A. Rich.) Dur. & Schinz.

Microcoelia moreauae L. Jonsson

Polystachya caespitifica Kraenzl. ssp. *latilabris* (Summerh.) Cribb & Podzor.

Polystachya vaginata Summerh.

Rangaeris musicola Summerh.

Tridactyle bicaudata (Lindl.) Schltr.

3.4 Key to the genera

A. Terrestrial herbs with creeping stems, pseudobulbs standing on rhizome:

B. Plants with tuberous or slender roots but without a perennial pseudobulbous base to the leafy stem . . . . . 1. Disperis

BB. Plants with a row or group of perennial pseudobulbs standing on a basal rhizome at or below the surface of the ground . . . 2. Eulophia

AA. Epiphytic herbs or lianes :

C. Leaves laterally compressed, overlapping at the base and forming a small fan . . . . . 3. Bolusiella

CC. Leaves flat, keeled or cylindrical and not laterally compressed, or plants leafless . . . . . D

D. Plants with pseudobulbs, growth sympodial :

E. Flowers resupinate (dorsal sepal uppermost) . . . . . 4. Stolzia

EE. Flowers not resupinate (lip uppermost) . . 5. Polystachya

DD. Plants without pseudobulbs, growth monopodial . . . . . F

F. Rostellum deeply indented and not elongate . . . . . 6. Angraecum

FF. Rostellum distinctly elongate . . G

G. Labellum distinctly 3-lobed . . 7. Angraecopsis

GG. Labellum not, or only indistinctly lobed . . . . . H

H. Flowers white :

I. Pollinia a single stipes and viscidium, sometimes the stipes lobed or divided in the upper part and bearing one pollinium on each lobe. . . . . 8. Aerangis

II. Pollinia with separate stipiles, and a common viscidium or 2 separate viscidia . . . 9. Rangaeris

HH. Flowers yellow or greenish but never pure white :

J. Flowers alternating along the inflorescence . . . . 10. Diaphananthe

JJ. Flowers in whorls along the inflorescence . . . . 11. Chamaeangis

3.5 Detailed taxonomic description of the genera and species

1. D I S P E R I S

Sw. in Vet. Handl. Stockholm, Ser. 2,21:218 (1800); in Bull. Herb. Bois, 6:911 (1898); Summerh. in FTEA I:216 (1968).

Terrestrial or epiphytic herbs, with mostly slender or small ovoid tubers, usually growing in very shallow soil or in leaf-mould forest. Stems short with 1-several sheathing scale leaves (cataphylls) at the base. Leaves 1-few, alternate, or in a single opposite pair. Inflorescence a terminal raceme or flowers solitary, borne in the axils of leaf-like bracts. Flowers small, mostly under 2.5 cm long, white, pink, yellow, green or purplish. Dorsal sepal united with petals to form a shallow rounded or deeply conical hood or galea; lateral sepals horizontal, upcurved or deflexed, each bearing a sac or spur near the inner margin. Petals variously shaped, often falcate obliquely acute or lobed at the apex, sometimes auriculate at the base. Lip remarkably modified, its claw joined to the face of the column and ascending above it, variously curving into the spur if present, often dilated into smooth or papillate straight or reflexed limb, which has an appendage at its apex which varies greatly in shape from species to species.

Column erect, mostly stout; rostellum with large, membranous 2-lobed, produced in front into 2 rigid cartilaginous arms, (fitting into the lateral sepal pouches when in bud holding the glands of the pollinia at their apices; anther-bearing part of the column horizontal or ascending; anther loculi distinct, parallel, more or less approximate, pollinia granules secund in a double

row on the margins of the flattened caudicles which curl up in a spiral on removal, staminodes present in some species; stigma 2-lobed, the lobes situated on either side of the adnate claw of the lip. Capsule cylindrical or ovoid, ribbed.

Species 75, extending from Togo and Ethiopia through tropical Africa to South Africa, the Mascarene Isls., India and New Guinea.

Disperis kilimanjarica Rendle in J.L.S. 30:400, t. 32/8-10 (1895); Schltr. in Bull. Herb. Boiss. 6: 937 (1898); Rolfe in F.T.A. 7: 290(1898); Tweedie in Journ. E.A. Nat. Hist.Soc. 24: 12(1964); Summerh. in FTEA 1:225(1968); Verdcourt in KB 41, 1:51-57(1986) Type: Tanzania, Kilimanjaro, slopes above Marangu (Morang), W.E. Taylor Sn. (B.M. holo.).

Glabrous herb, 7.5-12 cm. tall, arising from an ovoid tuber, 1-1.5 cm. long, 8 mm wide, sending out filiform tuber-bearing underground shoots. Leaves 2, alternate, sessile, sheathing at the base, ovate, 1.2-3.1 cm long, 0.7-2.1 cm. wide, acute, cordate above the sheath. Flowers solitary, white tinged green, margined with lilac along the edge of the spur, or pinkish, or distinctly green and dull mauve; bract 1,leaf-like, 0.8-1.5 cm. long, 4-8 mm. wide. Intermediate sepal hooded, joined to the petals to form a short spur 0.8-1.6 cm. long, broad towards its mouth, abruptly narrowed towards the apex; lateral sepals obliquely ovate, 0.6-1.2 cm. long, 4-5 mm. wide, apiculate, free, bearing sacs 2-2.5 mm. long. Petals irregularly oblong, 8 mm. long, 4 mm. wide, curved on united margins, irregular on free margins, shortly clawed at the base. Lip 6 mm. long, with linear claw expanded above into a narrowly triangular blade with a reflexed tip, which bears (at the point of reflection) a thick narrowly oblong appendage directed to the apex of the spur, 3 mm. long, papillate at the extreme tip (Plate 1).

DISTRIBUTION IN KENYA: K2,3,6.

HABITAT: In dense shade of evergreen forest mostly on branches covered with mosses and liverworts or in leaf-litter sometimes epiphytic on trees up to 6 m. above the ground; 2100-2700 m.

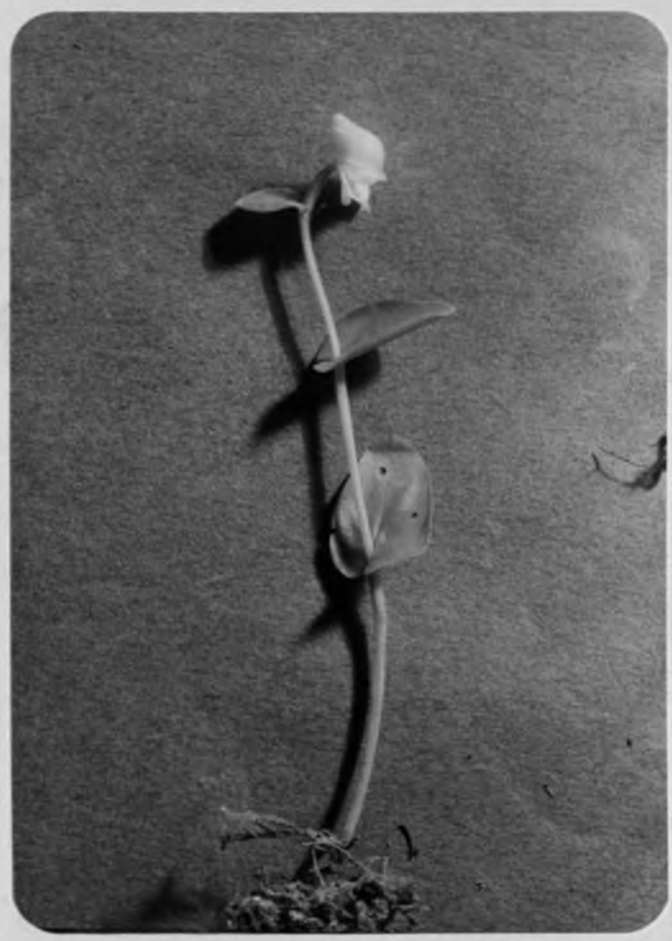


PLATE 1: Disperis kilimanjarica Rendle (x 1)

2. E U L O P H I A

Lindl. in Bot. Reg., 8, t. 686 (1823); Rolfe in FC. 5, 3:17(1912); Schelpe 1.c Dyer in Gen. S. Afr. 2:1001(1976).
Lissochilus R. Br.; Rolfe in FC. 1.c. 54; Phill. Gen. ed. 1:242 (1951),

Terrestrial herbs, rarely epiphytic, stems tuberous or rhizomatous or thickened into aerial pseudo-bulbs. The leaf-bearing shoot standing next to the flower-bearing stem, leaves basal, distichous, usually plicate. Flowers in laterally developed racemes or panicles, bracts small. Sepals subequal, free, sub-connivent, spreading or reflexed, laterals sometimes adnate to foot of column. Petals similar to sepals or broader, often differently coloured, lip continous with base of column, 3-lobed or sub-entire, variously saccate or spurred; disc variously cristate, lamellate, or sometimes produced into a foot at base. anther terminal, operculate, semiglobose, conical, or rarely acuminate or more or less biloded at apex, inperfectly 2-thecous; pollinia 4, united in pairs, attached to a broad caudicle and viscidium. Capsule oblong or somewhat linear with prominent thickened angles.

A genus of about 200 species; fairly cosmopolitan.

Eulophia streptopetala Lindl. Bot. Reg. 12: tab. 1002 (1826). Hall in J. S.Afr. Bot. v:123 (1965).sine leg., sine loc., ex hort. "Mr. Colvilles Nursery". Lectotype: incon., Bot. Reg. 12: tab. 1002 (1826).

An erect robust glabrous herb, 0.35–1 m high; leaves 4–6, sheathing at the base of the somewhat large pseudo-bulbs, erect-spreading linear-lanceolate, acute, articulate a little above the base, the primary nerves very prominent below, well developed during the flowering period, 15–35 cm long, up to 2.5 cm broad; scape stout, clothed with rather distant acuminate membranous sheaths; racemes laxly 7–15 flowered, flowers spreading, at length nodding; bracts oblong lanceolate, shorter than the ovary; sepals green, variously mottled with dark purple brown, more usually spreading, afterwards more rarely reflexed, oblong lanceolate, somewhat oblique, 1.2–1.4 cm long; petals bright lemon yellow, paler on the inner surface, more or less reversed through the twisting of the claw, somewhat rhomboid-orbicular, as long as the sepals; lip about as long as the petals, 3-lobed, lateral lobes dull purple, erect oblong-obovate, 0.5–0.7 cm long, intermediate yellow, convex oblong-obovate, tuberculate-cristate, the tubercles inconspicuous, 0.8–1.1 cm long, spur somewhat obconic, placed at the junction of the lobes, about 0.3 cm long; column oblong, affixed to an oblong stipe 0.3 cm long; ovary with the pedicel 1.5–2 cm long; capsule cylindrical, narrowed at the base, 4 cm long (Plate 2).

DISTRIBUTION IN KENYA: K3,4,5,6.

Habitat : Grows near bushes, trees, large herbs in thorn veld or at the margins of forests or bush clumps. 1200–2100 m.

PLATE 2: Eulophia streptopetala Lindl. (x1/6)

3. B O L U S I E L L A

Schlechter, Beih. bot. Centralbl. 36(2): 105(1918); Schelpe 1.c 52; Harrison 1.c. 45. Angraecum in part by Rolfe in FC. 5,3 : 73(1912); Phill. Gen. ed. 2:243(1951); Dyer in Gen. S. Afr. 2 :1004(1976).

Very small epiphytic herbs with short thin roots, stemless or with short leafy stems 5 cm long. Leaves distichous, ensiform, obliquely lanceolate to falcate, leathery. Inflorescence axillary, or arising below the leaves, racemes short, erect, slender with comparatively large bracts. Flowers white, pedicels very short. Sepals lanceolate; lip ovate lanceolate, acuminate, simple or 3-lobed with a short cylindrical spur. Column short; rostellum curved forward, anther capped; pollinia 2, subglobose, attached by separate caudicles to a common viscidium, capsule ovoid.

Species 6; from West and South-East Africa.

Bolusiella iridifolia (Rolfe) Schltr. in Beih. Bot. Centralbl. 36(2): 106 (1918). Type: Angola, Golungo Alto, Welwitsch 679 (K, holo.).

A dwarf epiphyte with a very short stem and fine, rather flattened, reddish fawn roots less than 1 mm. diameter.

Leaves bilaterally flattened, often recurved, fleshy, arranged in a fan, linear to narrowly oblong, obtuse to acute, 2.2–3 cm. long, 0.25–0.45 cm. wide, bronze-green to dark green. Inflorescences 1–several, 3–6 cm. long, densely many-flowered; peduncle very short; bracts distichous, almost imbricate, amplexicaul, ovate, acute, 1.5–2 mm. long, brownish black. Flowers companulate, white, very small; ovary 1 mm. long. Sepals oblong, obtuse, 2.85–3 mm. long, 1.2 mm. wide. Petals oblong, obtuse, 2.6 mm. long, 1.3 mm. wide. Lip oblong-lanceolate, subacute, 2.3 mm. long, 0.8 mm. wide; spur curved forwards under lip, subclavate, 2 mm. long. Column 0.5 mm. long; pollinia 2, ovoid, attached by an oblanceolate stipes to a short linear viscidium. Fruit almost spherical, 3 mm. long. (Plate 3).

DISTRIBUTION IN KENYA: K4,6.

HABITAT: On small branches of trees in and at edge of woodland and lower montane forest; 90–2200 m.

PLATE 3: Bolusiella iridifolia (Rolfe) Schltr.(x 1)

4. S T O L Z I A

Schltr. in E.J. 53: 564(1915); Mansf. in N.B.G.B. 11: 1061 (1934); Summerh. in K.B. 8: 140 (1953); Cribb in K.B. 33:78-89 (1978); Cribb in FTEA 2:330(1984).

Dwarf epiphytic or rarely lithophytic herbs with spreading growth. Stems pseudobulbous, repent, more or less forming mats on the surface of the substrate. Pseudobulbs assymmetrical, fleshy, ovoid, fusiform to clavate, bearing 1-2 leaves at the apex which is often offset. Leaves fleshy or coriaceous, spreading or erect, oval, ligulate or obovate. Inflorescence erect, 1-many flowered. Flowers solitary or in few-flowered inflorescences arising from the apex of the pseudobulb. Flowers more or less secund, somewhat campanulate, yellow, orange, brown, red or green. Lateral sepals fused at the base, forming with the column - foot a more or less prominent mentum. Lip entire, curved, V-shaped in cross-section. Column truncate, with a long curved foot, more than three times as long as the column; pollinia 8, in 2 groups, 4 larger and 4 smaller; stigma concave with a flap-shaped rostellum in front.

A genus of about 15 species, all from tropical Africa.

Stolzia repens (Rolfe) Summerh. in K.B. 8: 141(1953) & in F.W.T.A., ed. 2, 3: 226(1968); Piers, Orch. E. Afr., ed. 2: 145, figs. 52,53, (1968): Morris, Epiph. Orch. Malawi: 75(1970); Williamson, Orch. Sc. Afr. : 128 fig. 68/2, t. 105(1977); Cribb in K.B. 33: 87(1978); Cribb in FTEA 2:330(1984).

Type: Uganda, Brown(K.holo.).

A creeping dwarf epiphytic herb to 1 cm. high. Pseudobulbs prostrate except at apex, elongate - clavate or rhizomatous, to 3 cm. long, 0.3 cm. wide, bearing 2 leaves near insertion of next pseudobulb where the pseudobulb is broadest. Leaves 2, elliptic or obovate, 0.5–1.4 cm. long , 0.3–0.8 cm. wide, rounded. Inflorescence 1-flowered, borne between leaves on very short peduncle. Flower yellow, brown or reddish, ± striped red or brown. Dorsal sepal oblong-ligulate, to 0.7 cm long, 0.25 cm. wide, obtuse; lateral sepals obliquely oblong, to 0.6 cm. long, 0.24 cm wide, obtuse, united towards base with each other and the column-foot to form a saccate mentum. Petals slightly falcate-lanceolate , to 0.5 cm. long, 0.15 cm. wide, acute. Lip tongue-like to narrowly ovate, 0.2 cm. long, 0.1 cm wide, ± acute, slightly papillate below. Column truncate, 0.7 long; rostellum flap-like; column -foot curved, 0.2 cm. long anther-cap spherical-compressed smooth. (Plate 4)

DISTRIBUTION IN KENYA: K3, 4-6

HABITAT: Epiphyte on mossy trunks and branches in forest; 900–2200 m.

PLATE 4: Stolzia repens (Rolfe) Summerh .(×1½)

5. P O L Y S T A C H Y A

Hook., Exot. Fl. 2, t. 103 (1824), nom. Conserv. Epiphora. Lindl. in Hook., Comp. Bot. Mag. 2: 201 (1836);Cribb in FTEA 2:330 (1984); Dyer in Gen. S. Afr. 2:1000 (1976).

Small medium-sized or rarely large epiphytic or less commonly lithophytic or terrestrial herbs. Stems often short and sometimes variously thickened or swollen to form a pseudobulb at the base, caespitose or less commonly spaced on a creeping rhizome, sometimes branched or superposed with 1-several nodes bearing 1-several leaves. Leaves suberect to spreading, thin-textured, coriaceous or rarely fleshy, often distichous, linear or lanceolate to oblong-elliptic or oblanceolate, emarginate, acute, obtuse or acuminate at the apex. Inflorescence terminal, erect or pedulous, one to many flowered, simple or branching, branches sometimes secund; bracts sub-erect to reflexed, setose or lanceolate to ovate or obovate, acute or acuminate to mucronate. Flowers minute to fairly large, not resupinate, therefore dorsal sepal on lower side and lip uppermost; flowers range in colour from green and white through many shadows of yellow, orange and brown to pink, red, mauve magenta and deep purple. Combinations of colours occur in many species and sometimes the flowers are scented, often pubescent. Dorsal sepal mostly porrect, lanceolate, more or less oblique, attached to the foot of the column and slightly hooded at their apex to form a more or less prominent mentum from inside which the lobellum emerge, petals smaller than the sepals, linear to obovate. Lip entire to 3-lobed, with or without a basal callus, glabrous, pubescent or farinose, often recurved and difficult to flatten. Column porrect, mostly short and stout with a more or less

elongate foot; pollinia 2, obovoid, stipe 1, square or subtriangular to oblong or linear; viscidium small to large, circular or elliptic; rostellum mostly obscure, bifid in front, rarely slightly elongate and beak-like.

A genus of about 200 species, predominantly African but also found in the tropics of Central and South America and from Madagascar across to the Phillipes, Indonesia, New Guinea and Australia.

Key to Polystachya species

A. Leaves less than 6 mm. wide . . . 1. P. spatella

AA. Leaves more than 10 mm. wide or leaves absent . . . B

B. Plant with one leaf surmounting each pseudobulb at least when flowering . . . 2. P.cultriformis

BB. Plant without leaves, or with more than one leaf at the time of flowering . . . C

C. Flowers 6-8 mm. in diameter; lip the same as perianth but with yellow or orange central patch . . . 3. P. transvaalensis

CC. Flowers more than 10 mm in diameter; lip white . . . 4. P. campyloglossa

1. Polystachya spatella Kraenzl. in E.J. 19:251(1894); Rolfe in F.T.A. 7: 130(1897); Kraenzl in F.R., Beih. 39:105 (1926); Summerh in K.B. 1931: 387 (1931); Robyns & Tournary, F.P.N.A. 3:486)1955); Piers, Orch. E Afr., ed. 2:134(1968); Cribb in F.T.E.A. 2:370 (1984).

Type: Uganda/Zaire, Ruwenzori, Butahu Valley, Stuhlmann 2333 (B M, holo., K,iso.).

An erect or pendulous epiphytic plant to ± 25 cm long, stems slender, narrowly cylindrical 1.5–11 cm long, 1.5 mm wide, superposed, emitted from along length of old growth, covered by a number of scarious sheaths when young, 2–leaved towards apex. Leaves suberect, narrowly oblong–elliptic or linear, acute or rounded and unequally bilobed at apex, 3–7 cm long, 2.5–6 mm wide. Inflorescence unbranched, shorter than the leaves, 1–5 cm long, 2–8 flowered; bracts ovate to lanceolate, acuminate, 1.5–3 mm long. Flowers cream to yellow green, sometimes tinged pink. Dorsal sepal concave, ovate–lanceolate, acuminate, 4.5 mm long, 2 mm wide; lateral sepals very obliquely ovate, 5 mm long, 5.5 mm wide, shortly acuminate, forming with the column–foot a long cylindrical mentum 5 mm long, slightly wider towards the apex. Petals oblanceolate, acute, 4.5 mm long, 1 mm wide. Lip long–clawed, 3–lobed in apical half, 7.5–9 mm long 5.5 mm wide; side lobes rounded–elliptic, overlapping mid–lobe margins; mid–lobe rotund–quadrate, ± apiculate, ± pubescent, callus between the side lobes somewhat obscurely fleshy. Column slightly dilated above, terete, 2.5 mm long (Plate 5).

DISTRIBUTION IN KENYA: K3–6.

Habitat : Epiphyte in montane forest; occasionally in drier woodland, 1600–2700 m.

PLATE 5: Polystachya spatella Kraenzl. (×1⅖)

2. Polystachya cultriformis (Thou.) Sprengel in Syst. Veg. 3: 742 (1826); Kraenzl. in F.R. Beih. 39: 118 (1926); Summerh. in Bot. Leafl. Harv. Univ. 10:289 (1942), in K.B. 8: 139 (1953) & in F.W.T.A., ed. 2, 3: 225 (1968); Piers, Orch. E. Afr. ed. 2: 122 (1968); Stewart in U.K.W.F.: 766, Fig. (1974); Williamson, Orch. SC. Afr. 126, Fig. 65/21 (1977); Cribb in FTEA I.341 (1984)
Type: Mauritius, du Petit Thouars (P; holo.)

A glabrous epiphytic or lithophytic plant 6–24.5 cm tall: pseudobulbs from a short creeping rhizome, loosely clustered, narrowly cylindric to conical, 1.4–18 cm. long, 0.2–1.2 cm. in diameter, clothed in 1–6 membranous basal sheaths. Leaf obovate, ovate or elliptic, acute to obtuse, auriculate at the base, 3.2–36 cm, long, 1.2–5.5 cm. broad, coriaceous, articulated 2–6 mm. above the apex of the pseudobulb. Inflorescence usually longer than the leaf paniculate or rarely racemose, 4.4–29 cm. long, bearing up to 50 flowers successively; peduncle slender to stout, 3.2–21.5 cm. long; basal sheath membranous; bracts ovate-triangular, acuminate, amplexicaul, 2.5–4.5 mm. long. Flowers very variable in colour and size, white, yellow, green, pink or purple, ± yellow at the base of the lip. Dorsal sepal ovate-triangular, apiculate, 4–8 mm. long, 2–4.5 mm broad; lateral sepals obliquely triangular, apiculate, 5–8 mm. long, 3–6 mm. broad; mentum conical, up to 7 mm. high. Petals linear to spathulate, acute or obtuse, 3.5–7.5 mm. long, 1–2.5 mm. broad. Lip strongly recurved, ± shortly clawed, distinctly 3-lobed in the apical half, 4–7.8 mm long, 3–6 mm

broad; side lobes porrect, rounded in front; mid-lobe oblong-quadrate, shortly apiculate, 1.2–4.5 mm. long, 1.5–3.5 mm. broad; callus fleshy, ± central. Column semiterete, 0.5–3.5 mm. long; foot 1.5–6.5 mm. long; pollinia ellipsoid - globose. (Plate 6)

DISTRIBUTION IN KENYA: K1-7.

HABITAT: Moist - forest or other montane forests; 500 - 2950 m.

PLATE 6: Polystachya cultriformis (Thou.) Sprengel(× 5/8)

3. Polystachya transvaalensis Schltr. in E. J. 20: 28 (1895) Kraenzl. in F.R. Beih. 39:14(1926); Summerh. in K.B. 11:227 (1956): Piers, Orch. E. Afr. ed. 2:140 (1968); Stewart in U.K.W.F., 768, fig. (1974); Williamson, Orch. SC. Afr. 117, fig. 61/3 (1977); Cribb in F.T.E.A 2: 357 (1984).
Type: South Africa, Transvaal, near Barberton, Moodies, Culver 56(B. Lecto.; K. drawing).

An erect epiphytic plant, 7-53 cm high. Stems terete, 4-45 cm long, completely covered by imbricating leaf bases, 5-8-leaved. Leaves distichous, well spaced on stem, ligulate or linear-lanceolate, rounded or obstuse at apex, 4.5-13 cm long, 7-20 mm wide, drying black. Inflorescence erect, shorter to slightly longer than the leaves, unbranched or weakly 1-3 branched, 3-13 cm long; peduncle and rachis terete, 1-6 cm long, sparsely pubescent; bracts ovate, acuminate, recurved, 3-7 cm long. Flowers erect, glabrous on outer surface, sepals cream, yellow, yellow-green or orange, variously suffused with brown or purple, petals and lip dull cream to greenish veined with maroon. Dorsal sepal ovate or subacute, 5.4-8.2 mm long, 2.5-4.2 mm wide; lateral sepals obliquely triangular, acute or acuminate, 8.4-11.3 mm long, 6.2-9.5 mm wide; mentum cylindrical-conical, 5.5-9 mm long. Petals oblanceolate-subspathulate, acute to obtuse, 4.8-6.6 mm long, 1.1-1.9 mm wide. Lip long-clawed, recurved, obscurely 3-lobed in apical half, sinuses between the mid-lobe and side lobes obscure 6.6-10.5 mm.

long, 5.7-8 mm. wide; side lobes rounded; mid-lobe broadly triangular, 2.5 mm. long, 3.6 mm. wide, subacute, obtuse or shortly apiculate. Column semi-terete, 2.5 mm. long. (Plate 7)

DISTRIBUTION IN KENYA: K3-7.

HABITAT: Moist forest and mist forest; (1200 -) 1800 - 2900 m.

PLATE 7: Polystachya transvaalensis Schltr.(× 1)

4. Polystachya campyloglossa Rolfe in K.B. 1909: 366 (1909); Piers, Orch. E. Afr., ed. 2:120 (1968), pro parte; Stewart in U.K.W.F. : 768, fig. (1974); Cribb in F.T.E.A 2: 395(1984). Type: Kenya, "Mombasa", fl. in Cult. July 1909, Sander (K.holo.).

A small epiphytic plant to 12 cm high. Pseudobulbs clustered, ovoid to ovoid- conical, 1-23 cm long, 0.5-0.9 cm diameter, 2-3 leaved at the apex. Leaves narrowly oblong, oblong-oblanceolate or linear, subcoriaceous, spreading or suberect, 5-10.5 cm long, 0.7-2.1 cm wide, rounded or minutely apiculate at the apex, articulated at base to a conduplicate petiole, 1-1.6 cm long. Inflorescence erect, longer than the leaves, 2-6 flowered; peduncle subcompressed, pubescent, 5 cm long; bracts ovate to cordate, carinate, densely pubescent, mucronate, 5-7 mm long, up to 5 mm wide. Flowers variable in colour and size, pubescent on outer surface; sepals green, olive-green or yellow-green (rarely yellow); lip white; lines on side lobes with purple; callus yellow, often spotted crimson. Dorsal sepal ovate, concave, acute or apiculate, 8-13 mm long 4.5-7 mm wide; lateral sepals obliquely ovate-triangular, acute, 8-14 mm long, 7-10 mm wide; mentum broadly conical, 6.5-9.5 mm high. Petals oblanceolate, qbtuse or apiculate at apex, 6.5-9.6 mm long, 2-3(4) mm wide. Lip shortly and broadly clawed, 3-lobed, 6-9.5 mm wide when spread out, side lobes erect,

rounded, 4 mm. wide,densely clavate - pubescent; mid-lobe oblong or ovate, fleshy, 4-5 mm long, 2-3 mm. wide, acute, glabrous; disc fleshy, densely obovate - pubescent, with a conical callus at base of mid-lobe between the side lobes. Column short, stout, 3 mm. long (Plate 8).

DISTRIBUTION IN KENYA: K3-7.

HABITAT: Epiphyte in woodland ravine forest or montane forest; 1100-2700 m. (type said to be from Mombasa, but quite probably from inland).

NOTE: Polystachya campyloglossa Rolfe is a very variable species, particularly in its flower colour and size. Some Ugandan specimens had been observed to have green flowers while those from Tanzania have yellow green or olive sepals and one specimen from Kericho has citrine-coloured sepals. However, it has been impossible to correlate these differences in flower colour with any morphological variation.

PLATE 8: Polystachya campyloglossa Rolfe (× ⅓)

6. A N G R A E C U M

Bory, Voy. IIes Afr. 1:359.

t. 19 (1804); Rolfe in FC. 5, 3:68 (1912);

Schelpe, 1.c. 38; Harrison 1.c. 85–96;Garay in KB 28, 3:495–497 (1973); Dyer in Gen. S. Afr. 2:1003 (1976).

Epiphytic herbs, with short to elongate leaf stems, without pseudobulbs. Leaves sessile, distichous, more or less coriaceous, articulated to a persistent sheath, often more or less obliquely 2-lobed. Flowers in lateral racemes, rarely solitary, arising opposite the leaves. Sepals subequal; petals similar to sepals; with the lip different, sometimes markedly so, arising from base of column and continuous with it, produced at base into saccate or elongate spur, entire or tri-lobed. Column very short and broad, concave in front. Anther terminal, operculate convex, often produced in front, scarcely 2-thecous, pollinia 2, with single caudicle attached to viscidium -capsule oblong or fusiform.

Species over 206; Africa, Madagascar, Ceylon and Mascarene Islands.

Key to Angraecum Species

A. Plant stemless or almost so, with a tuft of 3-8 linear-lanceolate leaves, inflorescence of 3-15 flowers . . 1. A. sacciferum

AA. Plant with erect, pendulous or horizontal stem bearing alternate leaves, inflorescence of 1-2 flowers . . 2. A. erectum

1. Angraecum sacciferum Lindl. in Hook., Comp. Bot. Mag. 2: 205(1837); Bolus, l.c. Orch. Austr. Africa. 1 : E.10 (1893) Type: S. Africa, Drege s.n. (holotype K). (Agraecum) parcum) Schltr. in Engl., Bot. Jahr. 53:604 (1915) Type: Tanzania, Kyimbila, Stolz 640(B. holo†; K. iso).

A dwarf epiphytic or occasionally lithophytic herb with short stem, 1.5–3 cm long, covered by overlapping leaf bases. Leaves coriaceous, distichous, twisted at the base to lie in one plane, linear to narrowly elliptic, acute at obscurely unequally bilobed apex, 1.5–6 cm long, 0.3–0.5 cm wide, articulated to a short sheathing leaf base. Inflorescences 1-several, 2–8 cm long, 2–6 flowered; peduncle 2.5–6 cm long, rachis zig-zag; bracts elliptic, acute, 2–2.5 mm long. Flowers small, green, pedicel twisted markedly, sepals elliptic-oblong, obtuse, 2.7–3.7 mm long, 1.7–2 mm wide. Petals lanceolate, acute, 2.4–3.2 mm long, 0.8–1.1 mm wide. Lip conduplicate-concave, broadly ovate, acute, 2.7–3.3 mm long, 3–2.5 mm wide; spur very shortly cylindrical, truncate, upcurved above ovary, 1.8–2 mm long. Column 0.8 mm long; pollinia 2, each attached to a small elliptic viscidium. Fruit ellipsoidal, 7 mm long (Plate 9).

DISTRIBUTION IN KENYA: K3,4,6.

Habitat: On small trees in and at edge of montane forest and on rocks by rivers; 900–2200 m.

PLATE 9: Angraecum sacciferum Lindl. (x 2)

2. Angraecum erectum Summerh. in Kew Bull. 11: 232 (1956).

Type: Kenya, Kirichwa Kubwa, Bally CM 7532 (K. holo. EA. iso.!).

An epiphytic or scandent herb with erect, simple or little branching, somewhat bilaterally flattened stems up to 60 cm. long, 2-4 mm. diameter, covered by leaf bases with long flexuous roots emitted through leaf bases along the length of stem. Leaves distichous; spreading or suberect, coriaceous, ligulate or lanceolate-ligulate, unequally acutely or obtusely bilobed at apex, 2.8-8 cm. long 4-13 mm. wide, articulated at base to a compressed sheath. Inflorescence emerging from the leaf axils, one - or rarely two-flowered; peduncle 0.5-2.2 cm. long; bracts amplexicaul, ovate, acute, 2-3 mm. long. Flowers pale yellow-green, whitish green or pale salmon pink especially on spur and callus, turning white with age, scented at night, pedicel and ovary decurved, 5-9 mm. long. Sepals lanceolate or oblong-lanceolate, acute, 7.5 -14.5 mm, 1.7-5 mm. wide. Petals narrowly lanceolate, acute, 7-12.5 mm. long, 1.7-3.5 mm. wide. Lip broadly lanceolate, acuminate, recurved at apex, 6-11.5 mm. long, 2.5-4.5 mm. wide, with a low linear basal callus; spur more or less incurved or subsigmoid, cylindric-filiform, 13.5-23.5 mm. long. Column 1.6-2 mm. long; pollinia 2, ovoid, each attached to a small viscidium. Fruits elliptic-pyriform , 2.5 cm. long. (Plate 10).

DISTRIBUTION IN KENYA: K1,3,4,6.

HABITAT: On vertical tree trunks in shade in riverine forest and scrub in gulleys, 1400-2200 m.

PLATE 10: Angraecum erectum Summerh. (x ½)

7. A N G R A E C O P S I S

Kraenzlin in Engl. Bot. Jahrb. 28 (1900):171; Schlechter, Die Orchideen (1914):600-601, et in Beih. Bot. Centralbl. 36, Abt. 2(1918) 139-141-H.; Perrier de Bâthie in Humbert, Fl. Madag. Orchid. 2(1941) 80-86.

Epiphytic herbs with a more or less developed stem. Leaves coriaceous, 2-6, frequently obliquely curved; inflorescence raceme of distichous or sub-distichous flowers; 4-many white or greenish; bracts short but wide and completely surrounding the rachis, rachis articulate; pedicel articulated just above base. Flowers small or medium, labellum trilobate or trifid. Rostellum in 2 laminas, sometimes connate; auricles absent. Anther glabrous beneath, in front with a more or less developed labrum; pollinia each with a stipe and a viscidium, the 2 stipes and the 2 viscidia sometimes connate.

Species 10. Mainly an African genus.

Angraecopsis breviloba Summerh. in Bot. Mus. Leafl. Harvard Univ. 11(9): 256 (1945). Type: Tanzania, Mondul, Moreau 304 (K, holo.).

A dwarf epiphytic herb with a very short stem about 1 cm. long and numerous flexuous unbranched roots, 1.5–3 mm. diameter. Leaves few, deciduous, ligulate to oblanceolate, acute, 1.5–4 cm. long, 0.3–0.5 cm. wide, dull green, articulate at base to leaf sheath. Inflorescences spreading or ascending, 5–9 cm. long, densely many-flowered; peduncle 1–2 cm. long, bearing 3–4 sheathing bracts; rhachis flexuous, angled; bracts amplexicaul, 2–4 mm. apart, broadly ovate, 1.5 mm. long blackish. Flowers secund, pale green, slightly scented; pedicel and ovary 4–6 mm. long. Sepals oblong-elliptic, obtuse, 3–5 mm. long, 1.5–1.6 mm. wide. Petals lanceolate, acute, 2.7–4.1 mm. long, 1.1–1.5 mm. wide. Lip slightly uncurved, obscurely, 3–lobed at base, lanceolate, acute, 3.75–4.6 mm. long, 1.8–2 mm. wide; side lobes fleshy, tooth-like; mid-lobe much longer, fleshy, 2.5–3 mm. long; spur clavate, pendent, 4.25–4.75 mm. long. Column 0.65–1 mm. long; pollinia 2 each attached by a stipe to the linear-elliptic, viscidium rostellum porrect, bilobed. Fruit ellipsoidal, 7–9 mm. long. (Plate 11)

DISTRIBUTION IN KENYA: K4-6.

HABITAT: Epiphyte on small branches of trees in and on edge of montane forest; 1250 – 2240 m.

PLATE 11: Angraecopsis breviloba Summerh. (×1⅛)

8. A E R A N G I S

Reichb. f. in Flora 48: 190 (1865); Schltr. in Beih. Bot. Centralbl. 36(2):112(1918); Summerh. in Kew Bull. 1936: 227 (1936); Perrier de la Bathie in Humbert, Fl. Madag., 49 e Famille, Orchidees, 2 :90(1941); Summerh. in Kew Bull. 20:188(1966) and in Hepper. Fl. W. Trop. Afr. 3:265 (1968); Stewart in Kew Bull. 34: 2(1979).

Epiphytic herbs with short or elongated woody stems bearing numerous elongated aerial roots in the lower part. Stems usually unbranched, covered with the remains of overlapping leaf bases, bearing few to several leaves apically. Leaves in 2 rows, usually thick and fleshy in the living state sometimes leathery during the dry season, sheathing at the base, much longer than broad and usually wider in the upper half, unequally bilobed at the apex. Inflorescence lateral, a short or elongated raceme, rarely branched, few- to many-flowered. Flowers resupinate, white or variously tinted with green or brown. Sepals and petals free, spreading or reflexed. Lip entire, often similar to the sepals and petals, spurred at the base. Column short and stout or somewhat elongated and more slender, often narrowed towards the base and enlarged at the level of the stigma; androclinium straight or sloping, the anther cap sometimes beaked, rostellum entire, elongated, deflexed or porrect;

pollinia 2, sessile on a single stipes; viscidium variously shaped; stigma an oval or rhomboid sticky depression. Ovary elongated, straight, or curved. Capsule cylindric or ellipsoid, often much elongated.

A genus of approximately 60 species of which at least 26 occur in Africa and the remainder in Madagascar and the Comoro Islands. One species is recorded from both East Africa and Sri Lanka.

Aerangis thomsonii (Rolfe) Schltr. in Beih. Bot. Centralbl. 36(2): 121 (1918); Jex-Blake, Some Wild fl. Kenya; 141, fig. 114 (1948); Copley, Tweedie & Carroll in Journ. E. African Nat. Hist. Soc. 24: 36, 38)1964); Piers, Orch. E. Afr. ed. 2: 207 (1968); J. Stewart in Agnew, Upland, Kenya Wild Fl. : 792-3 (1974); Stewart in Kew Bull. 34, 2:264 (1979).
Type: Kenya, Thomson 131 (K. holo.).

Stem woody up to 10 mm. diam., 10-100 cm long, usually upright, at least in the terminal leafy part, covered with old leaf bases in the lower part from which whitish roots up to 9 mm diam. arise. Leaves 8-20 alternate, distichous, 1-3 cm apart, ligulate, apex unequally lobed, the lobes rounded or obtuse, the longer 5-10 mm. long, the shorter up to 5 mm long or absent, fleshy or leathery in texture, deep green, margins entire, 8-28 x 1.5-4.5 cm. Inflorescence borne at the nodes, of arching racemes bearing 4-10 flowers; peduncle terete, up to 9 cm long, 6 mm diam., bearing 2 or 3 tubular sheaths; rhachis ± straight, green, to 20 cm long, with a short projection 2-3 mm long in the axil of each bract; bracts very broadly triangular-ovate, obtuse or apiculate, cucullate, 10-15 mm. long. Flowers held erect in two rows, 1.5-3.5 cm apart, white, pedicel with ovary green, 3-6 cm long. Dorsal sepal erect, sometimes curving forward at the tip, lanceolate, elliptic, cuspidate, 22-30 x 7-9 mm; lateral sepals strongly reflexed, lanceolate elliptic, acuminate, winged on the back in the upper half, 25-32 x 5-6 mm. Petals reflexed, oblique lanceolate-elliptic, acute, 20-25 x 6-8 mm. Lip reflexed, elliptic-lanceolate, acuminate, margins recurved below, incoiled above, 20-25 x 7-8 mm; spur pendulous, flexuous, cylindrical but

widened and flattened in its terminal half, 10-15 cm long. Column erect, widened towards the apex, 6-8 mm. long; anther cap conical, rounded, pollinia oblong; stipes very slender, 3 mm long; viscidium round. (Plate 12)

DISTRIBUTION IN KENYA: K1-7.

HABITAT: Shady places, usually rather low down on trunks and branches in highland forest; 1600 - 2600 m.

PLATE 12: Aerangis thomsonii (Rolfe) Schltr. (x½)

9. R A N G A E R I S

(Schlechter) Summerh. in Kew Bull. 1936: 227 (1936); Kew Bull. 1949: 435 (1949); Schelpe, l. c. 44 in Obs.; Harrison l.c. 51 ; Dyer in Gen. S. Afr. 1005 (1976).

Epiphytic or lithophytic herbs with short woody stems. Leaves leathery, ligulate to oblanceolate, deeply keeled, acute to unequally bilobed; inflorescence axillary or arising below the leaves, erect or pendent, racemose, bearing white flowers that turn orange with age. Petals similar to sepals; lip ovate to lanceolate, sometimes trilobed at the base, with long spur. Column short or long; anthers capped, produced into a broad obtuse beak, pollinia attached by 2 separate caudicles to a single large viscidium.

Rangaeris amaniensis (Kraenzl.) Summerh. in Kew Bull. 4:438 (1949). Type : Tanzania, Amani, Braun 1551 (B. holo.† , K. iso.).

A pendent to erect, clump-forming, epiphytic or lithophytic herb with unbranched or little branched stems, up to 5 cm, covered by persistent leaf bases. Roots long, little branched, c. 4 mm. in diameter. Leaves distichous, coriaceous, conduplicate, narrowly oblong, unequally roundly bilobed at apex, 3.5–11.5 cm. long, 1–2.3 cm. wide, articulate to a short leaf base. Inflorescences one-many, 6–9 cm. long, 5–13-flowered; peduncle 1–1.5 cm, long; bracts 6–7 mm. long, drying brownish-black. Flowers star-shaped, white, fading to yellow with age, scented especially in the evening; pedicel and ovary 2.5–5.5 cm. long, scabrid. Sepals linear-lanceolate, acuminate; 1–2.5 cm. long; 0.27–0.6 cm wide. Petals similar, 0.9–2.1 cm long, 0.22–0.5cm wide. Lip obscurely 3-lobed in middle, 1–2.4 cm.long, 0.5–1.1 cm. wide; side lobes rounded, short; mid-lobe much longer,lanceolate, acuminate; spur filiform, pendent, 7.5–16 cm. long. Column 4.6–5 mm. long; pollinia 2, ovoid, attached by two stipes Fruit ellipsoidal 2.5–3 cm. long (Plate 13).

DISTRIBUTION IN KENYA: K1,3,4,6,7.

HABITAT : On trees and rocks in dry evergreen montane forest; 1100–2350 m.

PLATE 13: Rangaeris amaniensis (Kraenzl.) Summerh.(x 1/5)

10. D I A P H A N A N T H E

Schlechter, Orchid. 593 (1914) et in Beih. bot. Centralbl. 36(2); 95(1918); Summerhayes in Kew Bull. 14: 139(1960); Schelpe 1.C. 46; Harrison 1.C. 41. Rhipidoglossum Schltr. in Beih. bot. Centralbl. 36(2): 80(1918). Mystacidium in part by Rolfe in FC.5,3 : 76(1912); Phill. Gen. ed. 2: 243(1951); Dyer in Gen. S. Afr. 1004 (1976).

Epiphytic herbs with woody, short or elongate leafy stems. Leaves yellowish green, distichous, ligulate, flat to weakly keeled, unequally bilobed at apex. Inflorescence usually plentiful, spread along the stem below the leaves or axillary. Flowers whitish-green or yellowish-green, easily recognisable by their semi-transparent, diaphanous substance; sepals and petals similar, spreading; the lip broader than long; frequently with a small tooth at the base in the mouth of the spur. Column short and broad with or without a foot; rostellum straight. Anther capped; pollinia 2, attached by separate filiform caudicles to separate small viscidia.

A genus of about 42 species from Tropical Africa.

Key to Diaphananthe species

A. Lip broader than long, usually 4-lobed; petals and lip with markedly erose margins . . 1. D. pulchella

AA. Lip as long as broad or longer than broad; petal and lip margins entire :

B. Flowers yellowish green; leaves 5–7 mm. wide; lip ovate, acute . . 2. D. montana

BB. Flowers white; leaves 10–13 mm wide, lip ovate to subquadrate - oblong obtuse to truncate . . 3. D.subsimplex

1. Diaphananthe pulchella Summerh. in Bot. Mus. Leafl.Harvard Univ. 12(3): 102 (1945) & in Kew Bull. 14:141 (1960). Type: Tanzania, Amani, Moreau 64. (K. holo.).

A small erect to pendent epiphytic herb with a short to elongate stem, up to 13 cm. long, 3-4 mm. in diameter, covered by strongly compressed leaf sheaths; roots flexous, branching, grey, 4-6 mm. diameter, emitted throughout length of stem. Leaves more or less coriaceous, oblong-ligulate or linear-ligulate, rounded or obtusely unequally bilobed at apex, 4.5-15 cm. long, 7-11 mm. wide. Inflorescences axillary, 6-15 cm. long, sublaxly many-flowered; peduncle 1-2 cm. long, bearing a few ovate, subacute sheaths; rachis terete, 1 mm. diameter, bracts ovate-triangular, acute, 1.5-3 mm. long. Flowers translucent, white, pale yellow or yellow-green; pedicel and ovary 3-4 mm. long. Sepals oblong-elliptic to oblong, rounded or obtuse at apex, 4.75-7.5 mm. long, 2-3.75 mm. wide. Petals obliquely ovate or lanceolate-ovate, shortly acuminate, 4.25-7.25 mm. long, 3-4.75 mm. wide, denticulate on margins. Lip broadly flabellate -suborbicular, obscurely 3-4 lobed at apex, 6-9.25 mm. long, 7.25-10 mm. wide, denticulate on margin, with a tooth-like callus in mouth of spur; spur incurved, fusiform-cylindric, acute, 8.5-11.5 mm. long. Column fleshy, 1.8-2.8 mm. long; pollinia 2, subspherical , each attached by a linear stipes to an orbicular viscidium; rostellum 3-lobed with a spathulate mid-lobe and two shorter triangular side-lobes. Fruit ellipsoidal 15mm. long (Plate 14).

DISTRIBUTION IN KENYA: K3,4,6.

HABITAT : On Podocarpus etc. in montane forest and in woodland 900 -2400 m.

PLATE 14: Diaphananthe pulchella Summerh.(x⅓)

2. Diaphananthe montana (Piers) Cribb & J. Stewart in Kew Bull. 40(2) : 411 (1985)

Type: Kenya, Stewart 827 (EA. holo.!; K. iso.).

Angraecum montanum Piers in Die Orchidee 20:248 (1969).

A dwarf, erect to pendent, epihpytic herb with a slender stem, 9-25 cm long, covered by persistent leaf bases. Roots long, emerging all along stem through leaf bases, 2 mm diameter. Leaves distichous, subcoriaceous, linear, unequally roundly bilobed at apex, 3.6-7.5cm long, 0.5-0.7 cm wide, articulated to leaf base. Inflorescences one to many, 1.6-3 cm long; few-flowered; peduncle up to 1 cm long; rachis zig-zag; bracts amplexicaul, ovate, subacute, c. 3 mm long. Flowers yellowish green, small; ovary 5 mm long, scabrid. Sepals oblong-elliptic, obtuse, 4.3-5 mm long, 1.8-2 mm wide. Petals ovate-lanceolate, subacute, 3.5 mm long, 1.7 mm wide. Lip fleshy, ovate, acute, 3.5-3.8 mm long, 2.5 mm wide, with a low knob-like callus at base; spur slightly upcurved or straight, 5.5-6.5 mm long. Column 1 mm long; pollinia 2, ovoid, each attached by a linear stipe to a small elliptic viscidium; rostellum 3-lobed pendent, side lobes much longer than mid-lobe (Plate 15).

DISTRIBUTION IN KENYA: K2/3, 6 ONLY.

Habitat : On small trees on forest edges and in montane scrubby forest; 2400-2800 m.

PLATE 15: Diaphananthe montana (Piers) Cribb & Stewart (× 1)

3. Diaphananthe subsimplex Summerh. in Bot. Mus. Leafl. Harvard Univ. 12(3): 107 (1945) & in Kew Bull. 14: 141 (1960). Type: Kenya, Nanyuki, Moreau 578 (K. holo.).

A pendent epiphytic herb with elongate stems 7-60 cm. long, c. 30 mm diameter, covered by leaf bases throughout their length, leafy towards a pex only, with numerous flexuous long grey roots, 3 mm. diameter, emitted along the whole length. Leaves ascending or spreading, thin textured, distichous, oblique or curved, oblong-lanceolate, obliquely and acutely bilobed at apex, 4-5 cm. long, 1-1.3 cm. wide. Inflorescences axillary, erect-spreading, 1-1.7 cm long, 3-4-flowered; bracts triangular, acute, 1.5-2 mm. long. Flowers white; pedicel and ovary 0.8-1.2 cm. long. Sepals oblong-or ovate-elliptic, obtuse or rounded, 2.7-4.5 mm. long, 1.3-2 mm. wide. Petals obliquely triangular ovate, acute, 2.8-3.5 mm. long, 1.7-2.7 mm. wide. Lip suborbicular-quadrate, obtuse to obscurely 2 or 3 lobed, 2.5-3.6 cm. long, 2.8-3.5 mm. wide, with a tooth-like callus at base; spur filiform- cylindric, slightly incurved, 4.4-6.75 mm. long. Column 1.2-1.5 mm. long; pollinia 2, spherical, each attached by a linear stipes to an orbicular viscidium; rostellum porrect,3-lobed, with a fleshy spathulate mid-lobe and with very short side lobes. Fruit narrowly ellipsoidal, 16 mm. long (Plate 16).

DISTRIBUTION IN KENYA: K3,4,6.

HABITAT : On trees in woodland and montane forest, often by water; 1600-2400 m.

PLATE 16: Diaphananthe subsimplex Summerh. (x½)

11. C H A M A E A N G I S

Schltr., in Beih. Bot. Centrbl., 36, 2:107(1918); Summerh. in Hepper. Fl. W. Trop. Afr. 3:264 (1968).

Robust epiphytes with rather succulent leaves borne alternatively in 2 rows on elongated woody stems; leaves often oblong or obovate-oblong, flat, obtuse and unequally bilobed at apex; racemes of many small flowers, yellow, orange, or green, borne in pairs or whorls or rather lax inflorescences; sepals and petals very small and thick in texture, free; lip entire with a relatively long spur at its base. Rostellum entire, linear and short. Pollinia sessile, fixed on a single stipe, terminated by a single viscidium.

Mainly an African genus.

Chamaeangis orientalis Summerh. in Kew Bull. 6; 473 (1952).

Type : Kenya, Chyulu Hills, Cunningham-van Someren 19 (K. holo.;EA iso.!)

A pendent epiphytic herb with a moderately elongate stem 3–12 cm. long, 5 mm. diameter, with flexuous branching roots emerging from the lower part. Leaves distichous, fleshy-coriacous, spreading or recurved, ligulate, falcate, obscurely and obliquely roundly bilobed at apex, 8 cm. long, 0.7–2.5 cm. wide, often twisted at base to lie in one plane, rarely conduplicate. Inflorescences one-several, erect, spreading or pendent up to 30 cm. long, densely many-flowered; peduncle fleshy, 5–9 cm. long, 2–4 mm. diameter, bearing several laxly sheathing bracts, 2–7 mm. long; bracts amplexicaul, entire or 2–4 toothed, 3–4 mm. long. Flowers 2–4 at node, brownish yellow, ochreous or salmon-coloured, fragrant; pedicel and ovary 3–5 mm. long. Sepals oblong-elliptic, obtuse or rounded, 3–4 mm. long, 1.6–2.5 mm. wide. Petals obliquely triangular-ovate, acute, 2.6–3.5 mm. long, 1.4–2 mm. wide. Lip subfleshy, broadly ovate or elliptic-ovate, 3.2–3.5 mm. long, 2.3 mm. wide; spur filiform-cylindrical, 15–20 mm. long. Column 0.75–1.25 mm. long; pollinia 2, ovoid attached by two linear coherent stipiles to narrowly elliptic viscidium. Fruit curved-ellipsoidal, c. 1 cm. long (Plate 17)

DISTRIBUTION IN KENYA: K3,4,5,6.

HABITAT : Epiphyte in lower montane forest and on isolated trees near forest; 1500–2400 m.

PLATE 17: Chamaeangis orientalis Summerh.(×½)

CHAPTER FOUR

4. ECOLOGY OF THE ORCHIDS

An understanding of orchid ecology is a vital tool for the successful growing of orchids and is necessary for the prediction of orchid distribution. When the conditions under which various species grow are known, it becomes possible to predict where the species and other associated plants may be found (Withner 1974). Orchid ecology is a difficult topic because it cannot be confined. This study is therefore limited to some aspects of ecology that have special relevance to orchids.

(1) Location of the orchid on the phorophyte
(2) Shade
(3) Exudates from the phorophyte
(4) Associated species
(5) Habitat
(6) Substrate
(7) Altitude
(8) Height of the orchid above the ground
(9) The phorophyte of the epiphytes

Location on the phorophyte, exudates, height of the orchid above the ground and the phorophyte do not apply to *Eulophia streptopetala* which is terestrial.

The data were compiled from a series of field observations and consequently, statistically evaluated. IBM PC/XT computer was used and PANACEA computer programme was employed. A chi-square test (Sokal R.R. and Rohlf., 1969, 1981), was conducted to determine the independence of occurence or randomness of distribution of the orchid species in relation to various classes of parameters.

The various categories of classification are as indicated in the accompanying tables.

4.1 Location of the Orchid on the phorophyte

The 16 species were classified in three possible categories of occurence. (a) Main branch (b) Secondary branch (c) Inbetween branches (Table 4.1). The goal here was to determine if the occurence on the species is independent of the position or location of the host. The Chi-square statistical test was used to test for the independence. Results of the analysis indicated that the orchid species occurence is not independent of the location on the host.

$X^2 = 101.12$, df = 32 P = < 0.01

Differential distribution of the various orchid species on the phorophyte was apparent. Examining the proportions for the three categories, it was apparent that most of the species occur in the main branches (55.6%) followed by those on secondary branches (34.9%) with small proportions occurring inbetween branches (20.4%). A closer examination of the species occurence indicates that *Polystachya transvaalensis*, *Diaphananthe pulchella* and *Rangaeris amaniensis* occur mainly on secondary branches. *Angraecum* **erectum** and *Disperis kilimanjarica* occur in high proportions inbetween branches.

Table 4.1 : Location of the orchid on the phorophyte.

(The numbers indicate the individual plants of each species).

Species	Main branch	Secondary branch	Inbetween branches	Total
Chamaeangis orientalis	7	2	1	10
Polystachya campyloglossa	12	8	0	20
Diaphananthe montana	9	6	1	16
Bolusiella iridifolia	3	2	0	5
Polystachya spatella	3	3	2	8
Polystachya transvaalensis	12	18	3	33
Aerangis thomsonii	2	1	18	21
Angraecopsis breviloba	6	4	0	10
Stolzia repens	12	9	0	21
Angraecum erectum	0	1	2	3
Angraecum sacciferum	4	2	0	6
Disperis kilimanjarica	5	1	9	15
Polystachya cultriformis	6	3	0	9
Diaphananthe pulchella	0	2	0	2
Rangaeris amaniensis	1	2	1	4
Diaphananthe subsimplex	1	1	1	3

4.2 Shade

Light intensity was divided into three classes: (a) heavy shade (b) open shade (c) full sun (Table 4.2). The species occurring in heavy shade existed in a microclimate that differs little from that of the understorey herbs of the forest. Those in the light shade occupy a microclimate intermediate between that in the undergrowth and that in the open. They receive some shade but much less than the heavy shade species. The full sun species live on the topmost branches and twigs. They are almost fully exposed to the sun. The amount of light was estimated and it varied with the time of the day and cloudness of the sky. The chi-square stastistic was again used to test for independence of their occurence with respect to light and shade. The results led to the rejection of the hypothesis that the species occured independently of the type of shade. X^2 = 106.44, df = 32 and P = $<$ 0.01. Examining the results leads to the conclusion that a high proportion of the orchid species would be located in shaded parts of the phorophyte (42.5%) while a relatively small proportion would be located in open shade (19.8%) and full sun 37.7%). *Polystachya campyloglossa*, *Polystachya spatella and Eulophia streptopetala* are located in open shade while high proportions of *Polystachya transvaalensis*, *Diaphananthe pulchella*, *Rangaeris amaniensis*, *Aerangis thomsonii*, *Angraecopsis breviloba* and *Stolzia repens* would be located in full sun. The rest of the species occur mostly in heavy shade. *Diaphananthe subsimplex* occur in open shade and full sun.

Table 4. 2 : Shade (The numbers indicate the individual plants of each species).

Species	heavy shade	full sun	open shade	Total
Chamaeangis orientalis	4	1	2	7
Polystachya campyloglossa	7	10	12	29
Diaphananthe montana	16	1	2	19
Bolusiella iridifolia	4	0	3	7
Polystachya spatella	2	5	6	13
Polystachya transvaalensis	18	20	10	48
Aerangis thomsonii	8	16	1	25
Angraecopsis breviloba	2	11	3	16
Stolzia repens	8	13	3	24
Angraecum erectum	1	0	1	2
Angraecum sacciferum	11	0	3	14
Disperis kilimanjarica	18	0	1	19
Polystachya cultriformis	7	10	0	17
Diaphananthe pulchella	1	5	1	7
Rangaeris amaniensis	0	2	0	2
Diaphananthe subsimplex	0	0	1	2
Eulophia streptopetala	0	0	1	1

4.3 Exudates

The objective here was to determine whether phorophytes which exude latex have any effects on the occurence and abundance of the orchid flora (Table 4.3). The results of the chi-square statistic indicated that the occurence and abundance of the orchid species was dependent on the presence or absence of exudates in the phorophyte. $X^2 = 26.09$, df = 32 and P = < 0.1.

Almost all the orchid species occur on phorophytes devoid of exudates (97.2%) with the exception of *Disperis kilimanjarica*, *Polystachya cultriformis*, *Diaphananthe pulchella* , *Angraecopsis breviloba* and *Stolzia repens* which occur in small proportions, (2.8%) on phorophytes with latex.

Table 4.3 : Exudates.

(The numbers indicate the individual plants of each species).

Species	Phorophyte with exudates	Phorophyte without exudates	Total
Chamaeangis orientalis	0	7	7
Polystachya cultriformis	0	29	29
Diaphananthe montana	0	19	19
Bolusiella iridifolia	0	7	7
Polystachya spatella	0	13	13
Polystachya transvaalensis	0	49	49
Aerangis thomsonii	0	27	27
Angraecopsis breviloba	1	12	13
Stolzia repens	1	22	23
Angraecum erectum	0	2	2
Angraecum sacciferum	0	13	13
Disperis kilimanjarica	1	19	20
Polystachya cultriformis	3	12	15
Diaphananthe pulchella	1	6	7
Rangaeris amaniensis	0	2	2
Diaphananthe subsimplex	0	1	1

4.4 Associated species

The aim here was to determine if the occurence of the orchid species was independent of the other epiphytic flora. Three categories of associated species were considered. (a) Lichen (b) Moss (c)Ferns (Table 4.4). Application of the chi-square test led to the rejection of this hypothesis. Results of the analysis indicated that the occurence of the orchid species is not independent of the other epiphytes. $X^2 = 70.02$, df 32 and $P = < 0.01$.

It was apparent that most of the orchids are associated with moss (45.0%), followed by lichen (40.5%) with the least association with ferns (13.9%).

Polystachya campyloglossa, *Polyastachya spatella*, *Aerangis thomsonii*, *Angraecopsis breviloba* and *Diaphananthe pulchella* are associated mainly with lichens. *Diaphananthe cultriformis* occur in association with ferns. The remainder of the species occur in association with moss.

Table 4.4 : Associated species. (The numbers in the table indicate individual plants of each species).

Species	Lichen	Moss	Ferns	Total
Chamaeangis orientalis	2	4	3	9
Polystachya campyloglossa	18	11	3	32
Diaphananthe montane	8	22	2	32
Bolusiella iridifolia	5	6	1	12
Polystachya spatella	7	6	3	16
Polystachya transvaalensis	30	35	8	73
Aerangis thomsonii	16	14	4	34
Angraecopsis breviloba	12	1	0	13
Stolzia repens	12	16	3	31
Angraecum erectum	0	1	0	1
Angraecum sacciferum	5	10	3	18
Disperis kilimanjarica	3	14	1	18
Polystachya cultriformis	8	10	11	29
Diaphananthe pulchella	6	1	0	7
Rangaeris amaniensis	2	0	0	2
Diaphananthe subsimplex	2	0	0	2
Eulophia streptopetala	2	0	0	2

4.5 Habitat

The vegetation type in which the orchids were found was investigated. The habitat was classified into three categories. (a) Forest (b) Bushland and thicket (c) Open grassland, as described by White F., 1983, (Table 4.5).

The goal here was to determine if the occurence of the orchids is independent of the type of habitat. The chi-square statistic was used to test for the independence. Analysis of the results led to the conclusion that the occurence of the orchids is not independent of the habitat. $X^2 = 139.59$, df and $P = < 0.01$. Most of the species occur in the forest (39.9%) followed by bushland and thicket (35.3%) with less proportions occuring in the open grassland (24.8%).

Further examination of the orchid species, distribution showed that *Aerangis thomsonii*, *Angraecopsis breviloba*, *Polystachya cultriformis* and *Disperis kilimanjarica* occur in higher proportions in the forest, whereas *Polystachya transvaalensis* and *Diaphananthe montana* occur mainly in bushland and thicket. *Polystachya campyloglossa* occurs mainly on isolated trees in open grassland.

Table 4.5 : Habitat (The numbers in the table indicate individual plants of each species).

Species	Forest	Grassland	Bushland & thicket	Total
Chamaeangis orientalis	6	0	1	7
Polystachya campyloglossa	9	30	5	44
Diaphananthe montana	8	7	11	26
Bolusiella iridifolia	3	0	4	7
Polystachya transvaalensis	17	10	46	73
Aerangis thomsonii	12	5	10	27
Angraecopsis breviloba	12	1	3	16
Stolzia repens	13	3	8	24
Angraecum erectum	1	1	0	2
Angraecum sacciferum	3	7	4	14
Disperis kilimanjarica	16	0	6	22
Polystachya cultriformis	9	1	5	15
Diaphananthe pulchella	2	5	0	7
Rangaeris amaniensis	1	1	0	2
Diaphananthe subsimplex	2	0	0	2
Polystachya spatella	8	3	1	12
Eulophia streptopetala	0	2	4	6

4.6 Substrate

The aim here was to determine if the occurence of the orchids is independent of the substrate. The substrate was grouped into four categories (a) humus (b) mixed substrate consisting of humus, moss and lichen (c) bark substrate without any humus deposits (d) Ferns (Table 4.6). Results of the chi-square test indicated that the occurrence of the orchids is not independent of the type of substrate. $X^2 = 182.27$, df = 48 and $P = < 0.01$. The majority of the orchids occured in the mixed substrate (55.2%). A few occured in humus (21.8%) and bark (21.8%) and only two species occured in fern substrate (1.2%). *Polystachya campyloglossa*, *Diaphananthe montana*, *Polystachya transvaalensis*, *Aerangis thomsonii*, *Stolzia repens* and *Disperis kilimanjarica* occured in the mixed substrate.

Angraecopsis breviloba and *Diaphananthe pulchella* were found attached to the bark without humus deposits..

Table 4.6 : Substrate (The numbers in the table indicate individual plants of each species.

Species	Humus	Mixed substrate	Bark	Fern	Total
Chamaeangis orientalis	1	5	1	0	7
Polystachya campyloglossa	9	17	6	0	32
Diaphananthe montana	2	18	1	0	21
Bolusiella iridifolia	0	6	0	0	6
Polystachya spatella	7	5	1	1	14
Polystachya transvaalensis	10	28	1	0	39
Aerangis thomsonii	13	10	7	0	30
Angraecopsis breviloba	0	0	16	0	16
Stolzia repens	2	18	2	0	22
Angraecum erectum	0	0	2	0	2
Angraecum sacciferum	0	7	1	0	8
Disperis kilimanjarica	4	18	0	0	22
Polystachya cultriformis	5	8	1	0	14
Diaphananthe pulchella	2	3	15	2	22
Rangaeris amaniensis	2	0	2	0	4
Diaphananthe subsimplex	0	0	1	0	1
Eulophia streptopetala	0	1	0	0	1

4.7 Altitude

The altitude at which the various orchid species occured was recorded using an altimeter and classified into the following zones:

Zone	Altitude (m)
Lowland	2,000 - 2,150
Intermediate	2,150 - 2,300
Highland	2,300 - 2,450

The results indicated apparent confinement of the species to the various zones with slight overlap. (Table 4.7).

Table 4.7 : Occurence of orchids at different altitude zones

Zone	Species
Lowland	Angraecopsis breviloba
	Angraecum erectum
	Diaphananthe pulchella
Intermediate	Chamaeangis orientalis
	Polystachya campyloglossa
	Polystachya spatella
	Stolzia repens
	Angraecum sacciferum
	Rangaeris amaniensis
	Diaphananthe subsimplex
Highland	Diaphananthe montana
	Bolusiella iridifolia
	Polystachya transvaalensis
	Aerangis thomsonii
	Disperis kilimanjarica
	Eulophia streptopetala

On the whole, orchids in both individuals and species were abundant in the intermediate and highland zones and became less numerous in the lowland zone.

4.8 Height of orchids above the ground

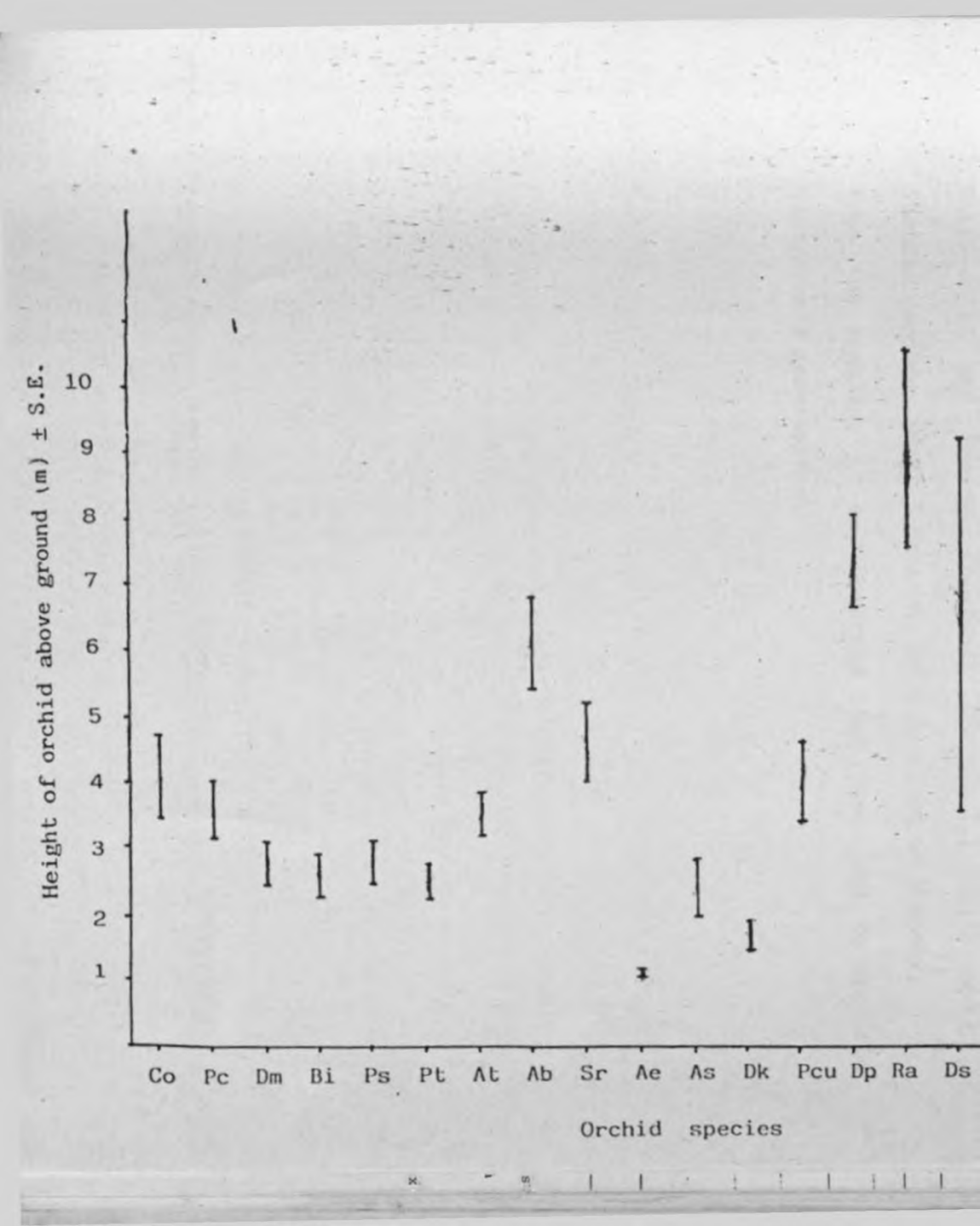
The distribution pattern of the individual species on the phorophyte was divided into three major levels based on the height of the orchid species above the ground.

Level	Height (m)
Low	0 - 3
Medium	3 - 6
High	6 - 9

Results indicated that different species are found at different levels fig. 4.1. Most species of orchids are more or less restricted to one or two particular levels of the phorophyte Table 4.8.

Table 4.8 : Occurence of orchids at different levels on the phorophyte

Level	Species
L O W	Diaphananthe montana
	Bolusiella iridifolia
	Polystachya spatella
	Polystachya transvaalensis
	Angraecum erectum
	Disperis kilimanjarica
	Angraecum sacciferum
MEDIUM	Chamaeangis orientalis
	Polystachya campyloglossa
	Aerangis thomsonii
	Stolzia repens
	Polystachya cultriformis
H I G H	Angraecopsis breviloba
	Diaphananthe pulchella
	Rangaeris amaniensis
	Diaphananthe subsimplex


Height of orchid above ground (m) ± S.E.
10
9
8
7
6
5
4
3
2
1
Co
Pc
Dm
Bi
Ps
Pt
At
Ab
Sr
Ae
As
Dk
Pcu
Dp
Ra
Ds
Orchid species

4.9 Phorophyte (Host species)

A total of 23 phorophytes of the epiphytic orchids in the area were collected and identified at the East African Herbarium. The number of orchids on each phorophyte were recorded (Table 4.8). It was observed that certain host species harboured a very high number of orchid species. The highest record was made on *Maytenus heterophylla* (Eckl.& Zeyh.) N.Robson Followed by *Nuxia congesta* Fresen. The other 'popular' hosts included *Albizia gummifera* (J.F. Gmel.) C.A.S.M., *Cussonia spicata* Thunb. and *Dombeya goetzenii* K. Schum. It was also observed that some orchid species had a wide range of distribution on different host species. *Polystachya transvaalensis* Schltr. was found on 14 different hosts, *Polystachya campyloglossa* Rolfe on 11 and *Aerangis thomsonii* (Reichb.f.) Schltr. and *Stolzia repens* (Rolfe) Summerh. were recorded on 9 hosts. From the results, it was observed that there was no specific host/orchid association.

Table 4.9 : Phorophyte

Phorophyte	Orchid species																
	Co	Pc	Dm	Bi	Ps	Pt	At	Ab	Sr	Ae	As	Dk	Pcu	Dp	Ra	Ds	Total
Cassipourea malosana	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Buddleia polyschya	1	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	5
Ekebergia capensis	1	2	0	1	3	0	1	1	2	0	0	1	3	0	0	0	15
Olea europeana ssp. africana	1	0	0	1	0	2	1	0	2	1	0	0	1	0	0	0	9
Maytenus heterophylla	0	6	7	2	4	35	5	0	7	0	11	10	4	1	0	1	93
Albizia gummifera	0	3	0	0	1	0	0	8	1	0	0	0	0	2	0	0	15
Dovyalis abyssinica	0	3	1	0	1	1	1	0	0	0	0	0	0	0	0	0	7
Dombeya goetzenii	0	3	0	0	0	0	1	2	2	0	0	2	0	0	0	0	10
Nuxia congesta	0	4	7	3	3	6	9	1	3	2	1	4	4	2	1		50
Cussonia spicata	1	2	0	0	0	1	2	0	3	0	0	0	1	0	1	0	11
Schefflera volkensii	0	1	0	0	0	1	0	0	0	0	0	2	0	1	0	1	7
Acacia xanthophloea	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
Pavetta abyssinica	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	3
Hippocratea sp.	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	0	5
Rhus natalensis	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Canthium oligocarpum ssp.friesiorum	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	2
Embelia schimperi	0	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	3
Dracaena afromontana	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Euphorbia nyikae	0	0	0	0	0	0	0	1	1	0	0	0	4	0	0	0	6
Euphorbia spicata	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	2
Ficus thonginii	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Rhus vulgaris	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1

Where:

Co	-	Chamaeangis orientalis	At	-	Aerangis thomsonii	Pcu	- Polystachya cultriformis
Pc	-	Polystachya campyloglossa	Ab	-	Angraecopsis breviloba	Dp	- Diaphanathe pulchella
Dm	-	Diaphananthe montana	Sr	-	Stolzia repens	Ra	- Rangaeris amaniensis
Bi	-	Bolusiella iridifolia	Ae	-	Angraecum erectum	Ds	- Diaphananthe sub-simplex
Ps	-	Polystachya spatella	As	-	Angraecum sacciferum		
Pt	-	Polystachya transvaalensis	Dk	-	Disperis kilimanjarica		

C H A P T E R F I V E

5. ENVIRONMENTAL IMPACT ASSESSMENT OF THE HILLS

The ever increasing human population is placing a burden on the natural resources, especially so on forests. The Ngong Hills forests are one such an area where intensive human activity has taken its toll to the extent that they have now been identified as an endangered ecosystem. The hills are a water catchment area for the upper Athi river and Kajiado. They also serve as a study area for Nairobi Educational Institutions. Before independence, the hills were a thick natural forest and for many decades, this area was used as a traditional dry season grazing ground by the Maasai.

Despite this apparently controlled grazing system, there was no significant detrimental effect on the status of the forest. But since 1967 there has been increased human settlement both controlled and spontaneous, which has led to rapid depletion of the forests at the rate of 18 hectares per year (Table : 5.1).

Table:5.1

Depletion rates and trend in the Natural forest cover of Ngong Hills:

(Source: Kenya Rangeland Ecological Monitoring Unit).

Forest	Gazetted forest area(ha)	Changes in stocked forest area (ha)				Annual rates of change(ha)
		1959/1967	1972	1976	1980	
Ngong Hills	2,244	394	184	184	156	18

This change has occured in the form of selective cutting of trees for wood, seasonal burning and browsing by animals, leading to, change in vegetation structure favouring the replacement of primary mountain forest by secondary bushland. On the east side the gentle slope and fair climate encourage human settlement above the settlement limit,whereas on the steeper west side, there is predominant charcoal burning and grazing. Environmental problems in this area stem in part from the proximity of Ngong Hills to the densely populated Central Province and Nairobi. The area can be analysed as a satellite of the Nairobi metropolitan area and yet it has limited environmental potential as an urban area, especially if increased urbanisation is largely the expansion in population of the urban poor, whose energy needs are primarily from woodfuel. Most of the area is arable farmland but this is likely to disappear with rapid expansion of settlement of people from other parts of the country.

According to the forester in charge of Ngong division (personal communication), the following are some of the factors believed to have led to the current status of the forests.

(a) The resident Maasai believe that the hills have some rain-making power and during the drought, they set them on fire so as to have rain. This is done once every three years.

(b) Charcoal burning is positively influenced by the ready market for the commodity from the urban dwellers.

(c) The Maasai view the hills as their property and therefore feel they have a right to cutting of trees and grazing freely.

(d) Most people do not seem to appreciate the importance of the forests in the long term. They view the mature trees in terms of how much they can fetch by felling them.

(e) The trees are being stripped off moss by people gathering for the florists in Nairobi. This poses a great danger to the epiphytic flora, to which the moss is a substrate and a means of support.

A survey carried out by the Kenya Rangeland Ecological Monitoring Unit (K.R.E.M.U) showed that in 13 years 60% of the forested area had been lost, reducing the forests from about 4 Km^2 in 1967 to 1.5 Km^2 in 1980, more than half the initial area of 394 hectares.

In 1983, the Permanent Presidential Commission on Soil Conservation and Afforestation visited the area and found that there were no trees except in the valleys. There was no grass cover, the little that was remaining had been grazed to the ground.

There was no control of grazing right up to the upper hills, making the catchment area bare, and reducing the interception of water. As a result, out of the 10 springs, only 2 were remaining in 1982. The water yield had been reduced from about 100,000 gallons per day to about 20,000 gallons per day. This was not enough to reach Kajiado (Shellat, Personal communication).

The Commission then undertook various control measures to prevent further damage and to improve areas already denudated. Re-afforestation was started with a view of restoring the water catchment role of the hills in 1983. A fence was constructed to mark the forest boundary and a tree nursery was set up. The area was gazetted in 1984 as a National Reserve under the Ministry of Environment and Natural Resources. Squatters were to be resettled from the catchment areas to the lower slopes of the hills.

Different species of trees both indigenous and exotic were recommended for re-afforestation with the aim of planting a natural mixed forest, without interfering with the ground cover. The trees selected had varying growth rates to allow for a good ground cover (Forester, Personal communication).

Two million seedlings were planted by 1985 and there was a plan to cover 2,500 hectares with forest. After 3 years of no disturbance, there has been a remarkable recovery. There is a new grass cover and 4 water springs are now flowing. Forest Rangers patrol the area.

5.1 Problems of Afforestation

An inspection tour in June 1983 revealed that the planted trees were being overgrown by weeds and there was poor management of the nurseries. Illegal squatters were still cutting the trees and a few livestock were still grazing up the hill. There were also cases of constant cutting of the fence wire protecting the nature reserve.

Reasons given for ineffective afforestation were that there was lack of technical personnel since the nursery was being run locally by the county council. Prolonged drought also affected the establishment of the seedlings. It was difficult to persuade the Maasai to remove their livestock from the area. Wild animals, especially the buffalos scared people and as such maintenance of the planted trees and springs was not carried out effectively(Nyaga, personal communication).

According to the forester, the current problems of afforestation include:

(a) Vermin, moulds and bugs, as pests.

(b) The short span of the rainy season does not allow for the establishment of seedlings.

(c) After the rains, the hills remain green longer and this attracts illegal grazers who introduce their livestock into the area.

(d) A lot of labour is required to raise the seedlings and the station's 16 effective workmen are not adequate for this task. Sometimes casual labour is hired, but has to be laid off when funds are not forthcoming.

(e) There is alot of interference from observers like politicians who happen to be decision makers but are not expert in field of afforestation.

To date women and children in particular still collect firewood and moss from the forest. Few of the recommended trees for afforestation are indigenous or have had extensive field trials and the long term survival is uncertain.

Indeed even the short term survival is compromised, both by special site incompatibility and often inappropriate planting techniques. The establishment rate for the seedlings planted has been low.

5.2 Recommendations:

(a) There is need to identify the critical parameters which influence the changes, determine the extent to which such parameters cause deforestation and gathering of appropriate information that can aid in the management of the forest resources in a sustainable basis.

(b) The area needs a clear cut forest boundary in order to stop cases of forest encroachment and the existing illegal settlements should be discontinued.

(c) There is need for massive effective educational programme aimed at fostering an understanding of our environment and its problems in order to attempt to harmonise future development and meaningful conservation of the resources therein.

(d) There should be rigorous afforestation programmes involving establishment of fuel wood plantations in order to contain the present forest destruction by easing the pressure off existing forest resources.

(e) There has to be an adequate and well distributed water supply now and for generations to come, unless the underlying causes of scarcity can be remedied , effective steps to try to correct the present mismanagement of this nature reserve may prove to be uphill task.

(f) In order to conserve the water supplies, cultivation and grazing on the steep sided ravines should be discouraged. Erosion control measures should be initiated, especially in areas already under crop production.

(g) Steps should be taken to prevent undue concentration of game animals at water holes during the periods when cattle are excluded.

(h) People need to change their attitude towards natural resources so that the setting aside some land for resource conservation may be viewed as a viable form of land use.

The present status of the Ngong Hills forest is likely to continue changing in view of the increasing demands for more land for agricultural settlement and fuelwood among other needs. It has been estimated that the forests will be entirely lost in about 30 years from now.

CHAPTER SIX

6. DISCUSSION AND CONCLUSION

Orchids in the tropics have not been well studied and a great deal of botanical description and revision is still going on. No serious work had been carried out on the orchid flora of the Ngong Hills prior to this study, except for casual identification by various collectors. Records at the East African Herbarium show that 21 species in 13 genera had been collected from the area. After the investigation a total of 17 species in 11 genera were recorded of which 16 were epiphytic and 1 terrestrial. 4 species were new records for the area whereas 8 species in 7 genera known to have been collected from the area before were not collected during this study. Possible explanation of the missing species could be the impact man has had on the environment of Ngong Hills. Many researchers including Withner (1974), have found that orchids are extremely specialised environmentally and are sensitive to slight environmental variation, making them valuable indicators of change in vegetation. The results of the study have illustrated that orchids of the Ngong Hills are in danger of extinction through the destruction of their natural habitat resulting from increased human settlement in the area. There has also been excessive collection of orchids for commercial purposes as a result of the value attached to the East African orchids by an increasing number of ethusiasts. In order to avert the trend in the vegetation on the hills, which will culminate in saving the orchid flora from extinction and stabilise the ecosystem, a few steps need to be taken.

The single most important undertaking is the conservation of the orchid habitats. Dressler (1981) has laid down guidelines for the conservation of orchids, where he suggests that orchids should not be collected in parks or nature reserves. He also feels that many plants of the same kind should not be collected, except in rescue operations neither should one collect plants which cannot be grown in their gardens or climate area. Information on the locality of a given species of orchids, especially those considered to be threatened with over exploitation, should by all means be withheld from commercial collectors. Orchid societies can contribute more to the conservation of orchids by organizing a countrywide survey that would determine the status of the orchid species in the country and indicating those that are truly endangered and possibly spell out remedial measures of their conservation. It is evident from this study that effective measures need to be taken to control the removal of orchids from their natural habitats, especially by collectors from outside the country.

Orchids are adapted to rather narrow environmental conditions. This is reflected in the findings of the various parameters studied, which compare well with the findings by other previous research workers. Withner (1974) has pointed out that the location of the orchid on the phorophyte varies with the orchid species, growth habit of the host, the position of the host in relation to other vegetation and with overall micro-climate and climate of the area. This study revealed that different species of orchids exhibited a well marked differentiation in locality on the phorophyte. Some species were found on the main trunk, others inbetween branches, while others 'prefered' twigs. No actual investigation has previously been done to describe or analyze this pattern. There is therefore, a need for further investigation in this area.

There is also a correlation between the shade and the habit of the various orchid species. There is a tendency for fast growing, thin leaved orchids to occur in moist shaded habitats whereas slower growing thick leaved forms occur in dry rather exposed habitats. Many workers including Withner (1974) have found that orchids will stand much greater exposure if root moisture is continually available and atmospheric humidity high. It has also been noted that orchids growing in sites where they are subject to dessication usually have water storage organs. Withner (1974) has pointed out that some orchids undergo structural modification related to light. Particularly noticeable are pigment changes of the stem and foliage, in response to exposure. These species tend to have an intense red-purple pigmentation as compared to the same species found in shaded sites which have the normal green colour. *Polystachya cultriformis*, *P.campyloglossa*, *P.spatella and Diaphananthe pulchella* are typical examples from this study. It is possible that the red pigmentation may have some adaptive value in reducing the leaf temperature.

There are large differences in the occurence of orchids on phorophytes with and without latex.Orchids seem to dislike hosts which exude latex such as most *Ficus* species and *Euphorbia* species. Allen (1969) claims that some kinds of bark are actually toxic to most orchids. The toxic effect of certain exudates may be the cause of the rarity of orchids on such phorophytes as revealed in this study. However possible general inhibition of plant growth by plant exudates and leachetes is a controversial field.

In regard to associated species, the intimate role of fungi in the life cycle of the orchids has received considerable attention from many researchers. Most orchids are now known to require a fungus known as Mycorrhiza to germinate successfully and supply the orchid with essential nutrients for growth. Observations from this study illustrated that most orchids were more frequent in areas least colonized by macroepiphytes like ferns, flowering plants and lianes which are possible competitors with orchids. Orchids were found at the end of fern colonies or missing altogether, but were often embedded in moss and lichen. Withner (1974) holds the view that it is extremely doubtful that lichens, mosses or liverworts are ever orchid competitors, rather they provide a suitable environment for seed germination and seedling development. They are also known for their rapid water uptake and moisture holding capacity which is of importance to orchids.

Orchids occur in a wide range of habitats. They are distributed through bushland, forests and grassland alike, although many individual species are severly restricted in their range Stewart et al. 1973). Different vegetation types favour different orchid species whether terrestrial or epiphytic. Some species prefer the dense forest canopy which provides a shaded and protected habitat. Others prefer the shelter given by low growing bushes and thickets, while still others are found in open grassland where they are completely exposed.

The type of substrate influences the distribution of orchids in nature. Different species often have a marked preference for

a certain kind of substrate. The present study revealed that most orchids occurred in a mixed substrate of humus, moss and lichens with least frequency of occurance in fern substrate. Possible explanation lies in the dynamic relationship that exists on a chemical level between the plant and the substrate, but research is needed to elucidate the complexity in this relationship.

The large altitudinal differences give rise to a number of different microclimates. It was observed that the orchid flora at higher altitudes differed from that at lower altitudes. Most species had a rather restricted range of altitude and were confined more or less to one of the zones, highland, intermediate or lowland. The effect of the altitude on epiphytes has been compared with either the water balance or the temperature (Johansson 1974). The lower the temperature, the higher the relative humidity and the presence of local cloud systems or mist at the highest parts of the hills will influence evapotranspiration favouring less drought resistant species. The higher light intensities that exist at the summit also favour some species.

The accumulated results from this study also revealed a regular pattern of distribution of orchids from the crown of the phorophyte down to the base of the stem. Johansson (1974), has pointed out that on all trees, there is a pronounced stratification of the epiphytic flora. The orchids that are common on the lowest parts of the trunks represent the most drought sensitive species. Higher up on the trees, orchids with somewhat fleshy leaves establish themselves.

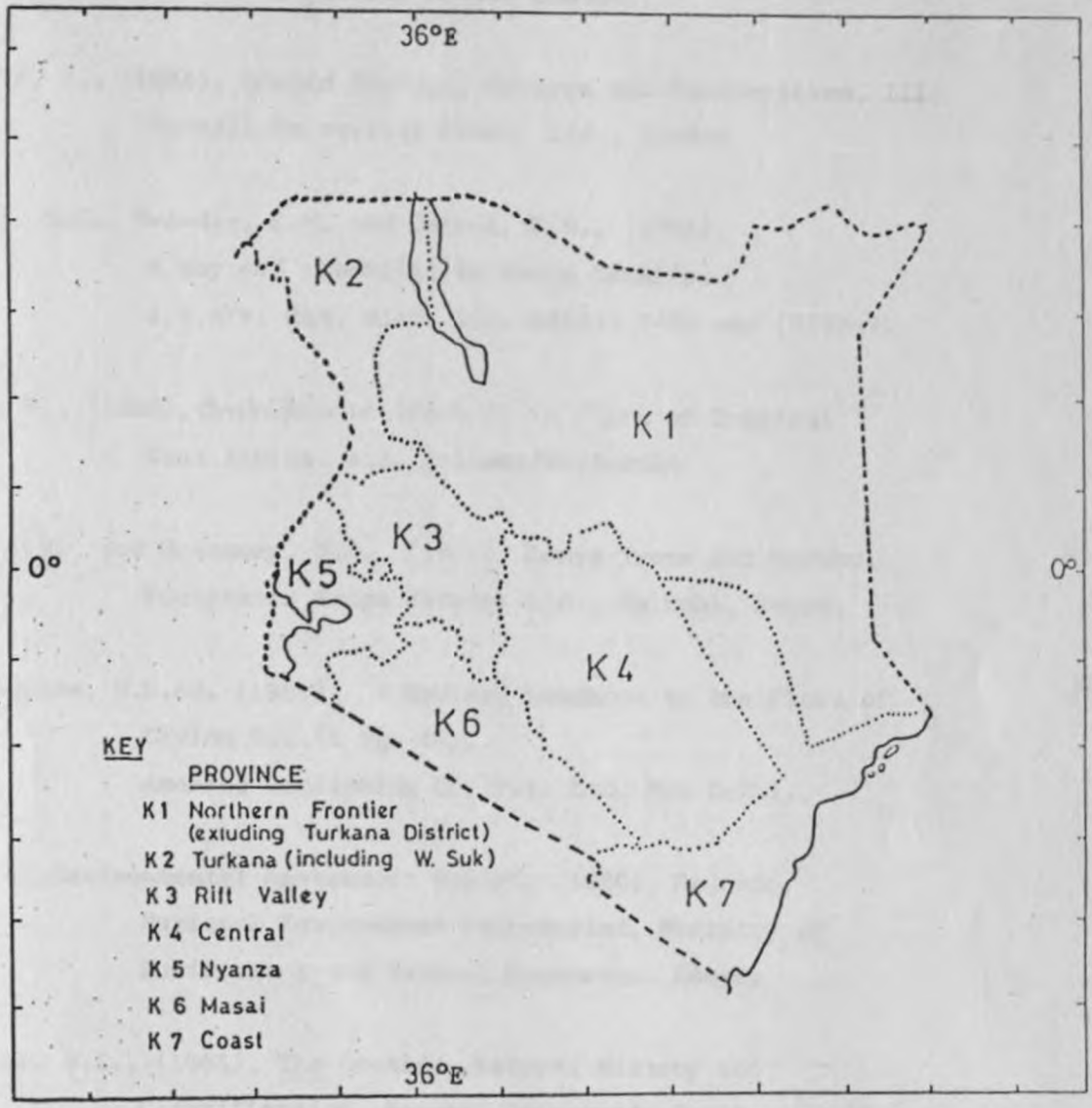
The tendency by some orchids to colonize certain species of phorophyte was observed, for instance *Angraecopsis breviloba* had a strong preference for *Albizia gummifera*. The orchid/phorophyte association has received considerable attention from many researchers. According to Went (1940), specific relationships between orchid and phorophyte species is usual. He states that the bark is responsible for orchid phorophyte specificity and he largely discounts both the physical structure of the bark and its water holding capacity as the variable factors leading to specificity. Rather he feels that it is largely the chemical composition of the water run off and leachates from it. Moreau & Moreau (1943) has argued that there is little evidence of specific relation between the orchid species and the host tree. In general rough bark is naturally more favoured than smooth. Withner (1974) agrees with the view that specific phorophyte-epiphyte species associations do not occur but the factors determining the presence of the host species together with the many variable characters of the host itself, determine the presence of orchids. With the information obtained from this study, it is suggested that few specific orchid/phorophyte relationships exist. The majority or orchids are found on a wide variety of hosts, but some phorophytes are orchid 'prone' for example *Maytenus heterophylla*. In very favourable sites, orchids can be found almost anywhere on almost any kind of host.

No single ecological factor exerts any direct influence on the occurence and distribution of the orchid species. It is the total

environment in the immediate vicinity of each orchid that is responsible for the particular orchid flora. Field analysis over a number of sites over several years will be necessary in the study of orchid ecology because of the slow growth rate of orchids and their specialized substrate demands.

Ngong Hills have for a long time been regarded as a source of unlimited resources to be tapped at will to meet short term cash needs, while taking the ecological benefits for granted. It is hoped that the findings of this study and the suggested conservation recommendations will stimulate the interest of conservationists and will lead to a better understanding of the need to conserve the area. The Hills have been gazetted as a nature reserve and it is now the policy of the Government to ensure that the area is effectively protected.

Fig. 6.1: Geographical Divisions of Kenya As Used In The Flora of Tropical East Africa



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